Corps of Engineers Northwestern Division
Columbia Basin Water Management Division
Portland, Oregon

2004

Water Quality Annual Report

Prepared with input from:
Portland District
Seattle District
Walla Walla District
Northwestern Division

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1. Executive Summary

This report on the 2004 Water Quality Program was prepared in conformance with ER 1110-2-8154 and NPDR 1110-2-101. This report focuses on water quality and includes some sediment quality as is appropriate. The report only covers programs and activities within the Columbia River Basin of the Northwestern Division (Portland, Seattle and Walla Walla Districts).

2004 regional highlights for the Columbia River Basin of the Northwestern Division include the following:

- There were 11.5 FTEs working in Water Quality programs in the Columbia River Basin achieving a wide array of objectives and goals, as described in this report.
- Columbia River Basin Water Quality Management Program contracts totaled of $2.6 million.
- The Reservoir Control Center, Water Quality Unit applied for and obtained a TDG variance from the state of Washington for the 2004 spill season. A 5-year TDG waiver from the State of Oregon was issued in 2003.
- The Reservoir Control Center, Water Quality Unit assisted in coordination for the development of a new Oracle-based Columbia Water Management System database system (Oracle-CWMS). Since full conversion to this new database system has not yet occurred, the Division is continuing to use the existing Columbia River Operational Hydrological Management System (CROHMS, a CDB-DSS database system).
- The Reservoir Control Center, Water Quality Unit successfully beta tested the SYSTDG model during the 2004 spill season. Potential future modifications were identified and steps were taken to ensure implementation for the 2005 spill season.
- The Reservoir Control Center, Water Quality Unit successfully managed the spill on the Columbia and Snake Rivers.
- The Reservoir Control Center, Water Quality Unit conducted temperature modeling on the Dworshak reservoir to assist TMT in their decisions on how to use the 80ft water releases.
- The Reservoir Control Center, Water Quality Unit participated in coordination related to various issues including TMDL's, UAA's, total dissolved gas, and water temperature through regional forums.
- Walla Walla District managed the operation and data collection for sixteen fixed monitoring stations for total dissolved gas (TDG), barometric pressure (BP) and temperature. Stations are located at Dworshak Dam tailwaters, in the forebay and tailwaters of the four Lower Snake River dams, at McNary dam forebay and tailwater on the Columbia River and on the Clearwater River.
- Walla Walla District performed a comprehensive review and evaluation of total dissolved gas monitoring stations that resulted in recommendations for remedial measures with respect to producing high quality objective data. Based on this work, the forebay fixed monitoring sites at McNary Dam, Ice Harbor, Lower Monumental, and Little Goose Dams will be relocated prior to the start of the 2005 spill season. These stations relocations are intended to avoid thermal influences that are experienced on the face of the dams.

- Walla Walla District provided technical assistance for data collection strategies with emphasis on evaluating water temperature effects from alternative river operations and providing data input for a working model. Water temperature data was collected at various pool locations in the Snake River Dam Reservoirs, Dworshak Reservoir and also in Snake River tributaries. Meteorological data, discharge and temperature data was summarized. Data evaluations were made based on heat flux and temperature variability.
- The Walla Walla district performed temperature monitoring continued as part of a multi-phase study to characterize temperature regimes and determine effects of temperature differentials on fish passage in adult fishways at McNary and the four Lower Snake River Dams.
- Walla Walla District's water quality section conducted water quality and limnological sampling at District reservoirs, and ponds. Technical assistance was provided for water and wastewater programs at Lower Granite and Little Goose Dams.
- The Seattle District continued routine water quality sampling at Libby Dam (Lake Koocanusa and the Kootenai River) and Howard Hanson Dam (Howard Hanson Reservoir and the Green River).
- The Seattle District continued real-time data collection of temperature and salinity in the Lake Washington Ship Canal to assist in operational decisions of the locks for control of saltwater intrusion into Lake Washington.
- The Seattle District continued to monitor total dissolved gas (TDG) at five (5) permanent sites located at the forebay and tailwater of Chief Joseph Dam, the forebay and tailwater of Albeni Falls Dam, and the tailwater of Libby Dam.
- The Seattle District completed a fish hatchery water quality study at Chief Joseph Dam to characterize the quality of relief tunnel, forebay, and irrigation well waters to determine if these water sources meet water quality criteria for use at a proposed Colville Tribe fish hatchery.
- The Seattle District implemented a water quality and sediment quality study at Chief Joseph Dam to establish baseline information on the physical, chemical, and biological condition of Lake Rufus Woods and the Columbia River.
- The Seattle District implemented a water temperature study upstream and downstream of Albeni Falls Dam to establish baseline information for the Pend Oreille River system and Lake Pend Oreille for future TMDLs, and to study how Albeni Falls Dam may impact the Pend Oreille River system.
- Portland District successfully installed and operated aeration equipment at Willow Creek reservoir that improved water quality conditions at the lake, including higher dissolved oxygen levels, and lower methane, hydrogen sulfide, and nutrient concentrations. Monitoring will continue in 2005.
- Portland District completed the CE-QUAL-W2 temperature models for Hills Creek, Lookout Point, and Dexter reservoirs. Models are being developed for Green Peter and Foster reservoirs. Portland District continues their efforts to be consistent with State TMDL requirements and evaluate future BiOp requirements.
- Portland District continued real-time TDG monitoring and temperature data collection at the Columbia River projects. Regular water quality monitoring continued at several Willamette and Rogue projects.

- The Portland District reviewed the draft Willamette Basin TMDL for temperature, bacteria, and turbidity within the Willamette System and temperature in the Rogue System and provided comments to the Oregon DEQ.
- The Portland District continued the collection of temperature data at selected sites below Lost Creek and Applegate reservoirs to obtain data on downstream impacts to water temperature.

2. Water Quality Management Program

2.1. Introduction

The U.S. Army Corps of Engineers (Corps) Northwestern Division (NWD) covers the largest geographical area of any division, spreading over 12 states and managing two major river basins. There are two regions and five districts in NWD: The Columbia River Basin portion of NWD focuses on the Columbia River basin its tributaries and is comprised of the three districts: Portland, Oregon; Seattle, Washington; Walla Walla, Washington. The Missouri River Region focuses on the Missouri River basin and its tributaries and is comprised of two districts: Omaha, Nebraska; and Kansas City, Missouri.

This report covers only the water quality programs associated with the Columbia River basin, and as a result, covers only Portland; Seattle and Walla Walla Districts' water quality activities. Omaha and Kansas City Districts submit a separate Annual Water Quality Report covering the water quality program in the Missouri River Basin.

The Corps' Water Quality Program are described in two main Engineering Regulations (ER): ER1110-2-8154 Water Quality and Environmental Management for Corps Civil Works Projects (January 31,1995) and ER 1110-2-1462 Water Quality and Water Control Considerations for Non-federal Hydropower Development at Corps of Engineers Projects (February 20, 1991). There are other engineering regulations that include water quality indirectly, such as ER 15-2-14 and ER 1130-2-540. This report conforms to ER 1110-2-8154, , and with NPDR 1110-2-101, Water Control Management - Quality, dated 19 December 1986.

2.2. Organization and Coordination

The Northwestern Division, Columbia Basin Water Management Division water quality program is divided into four sections: The Water Quality Unit at the Northwestern Division, Reservoir Control Center (RCC); Portland District; Walla Walla District and Seattle District. The Water Quality Unit of the RCC is responsible for water quality issues associated with spill for fish passage on the Columbia and Snake Rivers. This effort crosses three district boundaries, four state lines, numerous tribal reservations, and one international border. As a result, the Water Quality Unit addresses water quality issues regionally and coordinates with other federal and state agencies on various water quality issues that affect the Columbia and Snake Rivers. The Portland District covers most of the state of Oregon (except for the easternmost portion of the State) and a portion of southwest Washington. Walla Walla District covers most of the state of Idaho, the easternmost part of Oregon, and the

southeastern part of Washington. Seattle District covers most of Washington, northwestern Montana and northern Idaho.

At the district level, all three NWD Columbia Basin districts are assigned broad responsibilities in developing and implementing water quality management programs outlined as outlined in the Engineering Regulations. The water quality management programs can be divided into six major areas and they are:

1. Water quality monitoring - water quality monitoring for problem specific and routine activities.
2. Construction – Construction related studies to establish baseline conditions before construction and then compare water quality conditions after construction.
3. Environmental Restoration – Water quality activities related to environmental restoration planning studies and activities.
4. Clean Water Act and Endangered Species Act Issues – Water quality activities associated with these laws (see ER, Engineering Technical Letter and the 2004 Biological Opinion and Remand)
5. Planning Assistance to States - Water quality activities associated with cost sharing programs with the states to achieve common goals such as data collection for Total Maximum Daily Loads (TMDLs).
6. Restoration of Abandoned Mines – Water quality activities associated with restoration of abandoned mines or the effects of mining waste on rivers.

Districts are responsible for identifying and monitoring the water quality of their projects, especially in sensitive areas or where environmental regulations exist. They inform state and federal agencies of any water quality changes that may be of concern. They report emergency events to the Division's Readiness Management (Operations, Construction & Readiness Directorate). Some of their water quality activities overlap with other programs, such as the Defense Environmental Restoration Program and EPA Superfund Program. Water quality problems that can be resolved through reservoir operations are reported to the Reservoir Control Center for appropriate actions.

Primary responsibility for reservoir water quality programs rests within the Engineering Hydrology and Hydraulics Branch. The Portland District Reservoir Control and Water Quality Section manages the Districts' water quality program and resides within the Engineering Hydrology and Hydraulics Branch. The Seattle District Hydraulics and Hydrology Section manages the NWS water quality program and resides within the Technical Branch and Engineering and Construction Division. In Walla Walla District, the Engineering Hydrology and Hydraulics Branch and Operations Natural Resource Management Section through their Environmental Compliance Coordinators (Environmental Review Guide for Operations Coordinators) deal with water quality issues.

All NWD Columbia Basin districts have direct access to the Corps Engineer Research and Development Center (ERDC) in Vicksburg, MS and the Hydrologic Engineering Center in Davis, CA for physical and mathematical modeling support. Each district reports its water quality activities annually to the Northwestern Division, Columbia Basin Region for review, synthesis, reporting and posting on the Internet.

2.2.1. Assigned Responsibilities

2.2.1.1. Northwestern Division's Responsibilities

The Northwestern Division, RCC Water Quality Unit covers the states of Oregon, Washington, Idaho and Montana. The RCC Water Quality Unit is responsible for addressing water quality issues in two of the six major areas listed above and they are: water quality monitoring and Clean Water Act and Endangered Species Act. The following is a brief discussion of the RCC Water Quality Unit involvement in these areas:

- Water quality monitoring - The RCC Water Quality Unit negotiates, reviews and assists in establishing regional consensus and approval on the locations and representativeness of the TDG monitoring gages. The RCC Water Quality Unit also ensures that the real time water quality data is managed so that it is available for use in real time operations. The RCC Water Quality Unit ensures that the web reports from the CROHMS and CWMS databases are being posted every morning.

- Clean Water Act and Endangered Species Act issues - The RCC Water Quality Unit uses the TDG monitoring data to change spill levels at nine dams to promote the migration and survival of endangered fish in the Columbia and Snake Rivers. The RCC Water Quality Unit negotiates, reviews and assists in establishing regional consensus on Total Maximum Daily Loads (TMDLs) for TDG and temperature.

2.2.1.2. Portland District's Responsibilities

The Portland, Oregon district covers most of the state of Oregon, except for eastern Oregon. Portland district is responsible for addressing various types of water quality issues in the six major areas listed above. The following is a brief discussion of the areas the districts involvement is in:

- Water quality monitoring - Portland district maintains the total dissolved gas monitoring system for three large dams on the Columbia River (Bonneville; The Dalles and John Day). They also collect samples, perform studies and maintain monitoring systems for temperature and turbidity on several rivers in Oregon such as the Willamette, Santiam, McKenzie and Rogue Rivers.
- Construction related studies – Portland district constructed the Cougar Temperature Control Tower to improve river temperatures for the benefit of endangered salmon.
- Environmental restoration - Portland district has performed environmental restoration planning studies and restoration activities.
- Clean Water Act and Endangered Species Act issues – Portland district conducts routine water quality monitoring at projects and, in the future will be involved in TMDL and ESA studies and monitoring.
- Planning assistance to states - Portland district performed shared cost studies to collect temperature data to assist the states in establishing temperature TMDLs.

- Restoration of abandoned mines - Portland district can provide State DEQ with cost shared funding for abandoned mine clean-up studies.

2.2.1.3. Seattle District's Responsibilities

Seattle District covers most of Washington, northern Idaho, and northwestern Montana. The following is a brief discussion of the District's involvement in the six areas:

- Water quality monitoring - Seattle District is responsible for the TDG and temperature monitoring system for three dams in the Columbia River Basin: Chief Joseph Dam on the Columbia River Albeni Falls Dam on the Pend Oreille River; and Libby Dam on the Kootenai River. The district also conducts water quality monitoring for various chemical and biological parameters including, conventionals nutrients, metals, phytoplankton, and zooplankton at several reservoirs and rivers in Washington Idaho, and Montana.
- Construction related studies - The District's water quality team provides technical expertise in regards to water quality issues that may be involved in various COE construction projects. When necessary, they also design and implement monitoring and sampling programs for these projects.
- Environmental restoration - Seattle District provides water quality assistance to environmental restoration projects whenever necessary.
- Clean Water Act and Endangered Species Act issues - Seattle District is involved in various water quality monitoring programs to ensure that all projects operate in accordance with the Clean Water Act and the Endangered Species Act. Further details are described in section 5.
- Planning assistance to states - The Seattle District performed no shared cost studies to assist the states.
- Restoration of abandoned mines - The Seattle District currently has one project funded through the Corps Restoration of Abandoned Mine Sites (RAMS) program, and attends RAMS meetings. The District continues to be an active participant in the RAMS program.

2.2.1.4. Walla Walla District's Responsibilities

Walla Walla district covers most of the state of Idaho, the eastern most part of Oregon, and the southeastern part of Washington. Walla Walla district is responsible for addressing various types of water quality issues in five of the six major areas listed above. The following is a brief discussion of the districts involvement in the five areas:

- Water quality monitoring - Walla Walla district responsible for the TDG monitoring system for six dams: one large dam on the Columbia River (McNary); one on the Clearwater River (Dworshak) and four on the lower Snake River (Lower Granite; Little Goose; Lower Monumental; and Ice Harbor). They also collect samples, perform studies and maintain monitoring systems for temperature and turbidity on several rivers in Oregon, Washington, and Idaho.

- Construction related studies - There were no water quality construction related projects in fiscal 04.
- Environmental restoration - Walla Walla district had no water quality related environmental restoration in fiscal 04.
- Clean Water Act and Endangered Species Act issues - Walla Walla district Planning section maintains compliance with the Clean Water Act and endangered species act. Their activities include consultation, coordination, obtaining permits and clearances. Not applicable to water quality unless Walla Walla Hydrology Section monitors for water quality under specific studies or related projects. This was not applicable in fiscal 04.
- Planning assistance to states - Walla Walla district performed no shared cost studies to assist the states.
- Restoration of abandoned mines - Walla Walla district discussed restoration of some Idaho mines in previous years but nothing has become of it.

2.2.2. Collaboration with Corps Labs and Centers of Expertise

Seattle District is the only district within the Northwestern Division, Columbia Basin region with a Corps owned lab. The Seattle District maintains its own on-site laboratory for the collection and analysis of water and sediment samples. Analysis equipment available includes Hydrolab multi-probe water quality samplers (containing one or more of the following probes: total dissolved gas, turbidity, conductivity, pH, dissolved oxygen, temperature, depth), Orion pH, dissolved oxygen and conductivity meters, Hach turbidity meters, Vemco temperature loggers, and NIST certified thermometers and barometers. Sampling equipment available includes vertical point water samplers, a Ponar sediment sampler, and a simple plankton net. In addition, each project in the Seattle District operates and maintains sampling boats equipped with winches and depth sounders. The on-site laboratory is equipped to handle the calibration of field instruments and the QA/QC of total dissolved gas and temperature instruments. The laboratory has equipment to maintain and repair Hydrolab and Orion sampling equipment.

The Water Quality Unit in the Reservoir Control Center collaborates with Dr. Michael Schneider of the Engineer Research and Development Center (ERDC) on the development of a total dissolved gas model called SYSTDG that simulates total dissolved gas levels on the Columbia and Snake Rivers. The RCC Water Quality Unit's collaboration with Dr. Schneider also involved using his expertise in running temperature model simulations of Brownlee reservoir releases with the CE-QUAL-W2 mode. Dr. Schneider also provided training on the SYSTDG model and developed a users manual for the SYSTDG model users.

2.2.3. Coordination through National Corps Communities of Practice

Jim Adams, Water Quality Unit Team Leader, RCC and David Ponganis, Senior Environmental Specialist with the NWD Portland office, represents the NWD Columbia Basin Region at one national Corps committee, the Corps' Committee on Water Quality.

The district water quality specialists have not been directly involved in national corps committees.

2.2.4. Cooperation with Other Agencies and Groups

District and Division staffs routinely coordinate with Federal, State, and local agency environmental quality counterparts. The listing of twelve Pacific salmon species under the Endangered Species Act (ESA) has made this coordination critical since the Corps is responsible for the operation of its project for multiple purposes. All water users have a vested interest in what operation is being planned by the Corps, where, when, and how.

NWD Columbia Basin Water Quality Unit of the Reservoir Control Center, in the Water Management Division, plays an active role in implementing the spill measures contained in the NMFS's 2000 Biological Opinion. There is continual dialogue between RCC and the Bonneville Power Administration (BPA), U.S. Bureau of Reclamation, Public Utility Districts, state and federal fishery agencies and Indian Tribes. The RCC makes all final reservoir regulation decisions and spill changes, frequently based on recommendations from the Technical Management Team, a mid-management level group set up by NOAA Fisheries in 1995 and chaired by the Corps representative.

NWW cooperates with the U.S. Department of Energy in analysis of existing data, development of GIS, and plans for future activities in water quality and fishery programs. Studies of sediment pollution for dredging activities are performed in cooperation with EPA and the Washington Department of Ecology. Coordination with the State of Washington Department of Ecology, State of Idaho Division of Environmental Quality (IDEQ), NOAA Fisheries, and ODEQ is performed for NPDES permitting activities. Contacts with IDEQ, State of Washington Department of Ecology, EPA, and U.S. Department of Energy are also needed to help address sediment transport and contaminant concerns.

3. NWD, Reservoir Control Center Activities

3.1. Introduction

The Water Quality Unit in the Reservoir Control Center (Water Management Division, Directorate of Programs) addresses water quality issues that need a regional approach such as TDG management and TMDLs on the Columbia and Snake Rivers. The RCC Water Quality Unit also provides technical and policy guidance on NWD Columbia Basin water quality programs. The RCC Water Quality Unit is responsible for monitoring the TDG and water temperature conditions in the forebays and the tailwaters of the lower Columbia River/ lower Snake River dams, and selected river sites. Based on the results of the TDG monitoring, the RCC Water Quality Unit are to set fish spill levels at the dams (daily if necessary) so that the river waters are close to, but do not exceed State Water Quality Standards. This team also addresses variances from the total dissolved gas water quality standard, for the purpose of improving conditions for fish, with the appropriate States and tribes impacted by the program implemented in the Federal Columbia River Power System

(FCRPS) for which the Corps has responsibility. As a long-term strategy, the Corps opened discussions with the State of Washington about replacing the year-to-year variances with long-term variances. The Corps already has in place a long-term variance from the State of Oregon that runs through the 2007 spill season.

The overall goals and objectives of the RCC Water Quality Unit are summarized in the following list:

- Participate in the development of a CENWD Columbia Basin Water Quality Unit to provide regional program management guidance.
- Monitor and adjust spill levels at nine Corps dams in the Columbia River Basin during the fish spill season to maintain temperatures at 68F and TDG levels below the state standards of 115% in the forebays and 120% in the tailraces.
- Work with appropriate State water quality agencies to obtain multi-year TDG variances of the 110% state standards.
- Work with the Hydrologic Engineering Branch (HEB) at NWD Portland office, to ensure that water quality data is migrated into the new Corps Water Management System (CWMS)
- Develop and implement 1-year and 5-year Water Quality Plans as specified in the August 30, 2004 Updated Proposed Action (UPA).
- Maintain staff capability in state-of-the-art water quality technologies such as TDG and temperature modeling, and data correction and validation software.
- Implement reliable and adequate monitoring programs to support water management functions in an efficient and expeditious manner;
- Foster close cooperation with other Federal, State, and local agencies involved in water quality programs.

3.2. Summary of Water Quality Conditions, Data Collection and Analysis and Other Activities/Investigation:

The RCC Water Quality Unit does not manage or work on project specific water quality issues, such as PCB contamination below Bonneville dam. Rather, the RCC Water Quality Unit works on water quality issues that are regional in nature and span the watershed through multiple district and state boundaries thus are regional water quality issues. These regional water quality issues include spill management and TDG monitoring of the Columbia and Snake Rivers, TDG and temperature modeling, TMDLs, Use Attainability Analysis (UAA), water quality data management,. The following is a brief description of the work performed on these regional water quality issues:

3.2.1. Spill management of the Columbia and Snake Rivers

Each year, in accordance with ESA and CWA responsibilities, the RCC Water Quality Unit adjusted the spill caps daily for the projects on the Columbia and Snake Rivers from April 3 through August 31st. To adjust the spill caps, The RCC Water Quality Unit reviewed a total of 16 factors, such as reviewing the TDG and temperature monitoring data; climate and flow forecasts; spill graphs and simulation results from the SYSTDG model. The number and

types of TDG and temperature exceedances were tracked during 2004 spill season. The results were posted on the Technical Management Team website for the regional organizations to review.

3.2.2. TDG and Temperature Monitoring of the Columbia and Snake Rivers

Since the Water Quality Unit reviews the real time water quality monitoring data to set spill caps each day, the monitoring data must come in and be posted on the Internet promptly. If the monitoring data is not posted, the Water Quality Unit takes steps to ensure that the problem is identified and corrected. When there are changes proposed to the monitoring system, the Water Quality Unit interacts with the districts and the Regional Forum Water Quality Team to obtain comments and recommendations.

3.2.3. TDG Modeling

During the 2004 spill season, the Water Quality Unit beta tested the SYSTDG model, which Dr. Michael Schneider from ERDC developed to simulate TDG levels on the Columbia and Snake Rivers. Based on this experience, the Water Quality Unit wrote a step-by-step guide on how to use SYTDG in real time operations, which was added to the SYSTDG users guide that Dr. Schneider wrote. The Water Quality Unit also developed a list of future developments to SYSTDG. The use of SYSTDG model during the spill season appears to have reduced the number of TDG exceedances credited to uncertainties when using best professional judgment to apply the spill guidance criteria (travel time; degassing; water temperature effects; spill patterns).

3.2.4. Temperature Modeling

During 2004, modeling water temperatures was an important issue concerning the Snake and Clearwater rivers to consider proposals for reducing summer spill in the lower Columbia River with appropriate offset actions, including releasing 100 KAF from Brownlee Reservoir during July. To address the technological need of the discussion, the Water Quality Unit coordinated with Dr. Michael Schneider from ERDC to have various alternatives modeled. Dr. Schneider used the CE-QUAL-W2 model, which he is currently modifying the programming code to more correctly model the Snake and Clearwater rivers. Discussions of future operational needs at Brownlee Reservoir or other Upper Snake River reservoirs are expected to continue because the FERC license for the Hells Canyon Complex (Brownlee) is being renewed, so temperature modeling is an important continuing need.

Since 2003 the Regional Forum Technical Management Team asked how long cool water from Dworshak water could be released in that year. The Water Quality Unit developed an approach to answer this question and designed a mass and temperature balance of the reservoir. With the use of the mass and temperature balance, the Water Quality Unit made an estimate of how long water could be released at a temperature of 43 and 45 ^{o}F. These estimates were used effectively to modify the summer flow augmentation operations through adaptive management at the Dworshak dam in an attempt to cool the Lower Snake River

water temperatures. Discussions of cool water releases from Dworshak Reservoir will continue making temperature modeling to be used in real-time decision-making an important continuing need.

3.2.5. Water Quality Data Management

The Water Quality Unit was involved in ensuring that all water quality data related issues are addressed in the CROHMS data management system conversion to CWMS. To achieve this goal, the RCC Water Quality Unit is involved in the CWMS pathname committee, reviewing the water quality parameter pathnames from the CBT and GOES data feeds. The RCC Water Quality Unit also developed a punch list with all the water quality web page reports that need to be converted. Once the reports were converted, they were reviewed to ensure they match the previous reports with all the needed information. While reviewing the water quality parameters pathnames, the CWMS and CROHMS data is also compared to find any errors in the conversion. A master list of the conversion errors is being created, which will be addressed once the conversion is complete.

3.2.6. Total Maximum Daily Loads (TMDLs)

The Water Quality Unit was involved in reviewing and providing input to the States of Oregon and Washington, and the Environmental Protection Agency Region X on the development of TMDLs for total dissolved gas and water temperatures for waters in the Columbia River Basin.

3.2.7. Use Attainability Analysis (UAA)

The Corps has actively worked with the Oregon Department of Environmental Quality on the development ODEQ's Internal Management directive for conducting a Use Attainability Analysis. This included participation in a workgroup of Federal, state, and tribal representatives and other interest groups.

3.2.8. Regional Coordination of Water Quality Issues

There are many different regional water quality issues that involve a considerable amount of coordination with other state and federal agencies regional organizations. The following are a list of the coordination the Water Quality Unit performs during the year:

The Water Quality Unit coordinates and schedules short and long-term reservoir operations for water quality issues that impact fish passage and fishery research.

The Water Quality Unit represents the Corps as an active participant in the Regional Forum Water Quality Team on all water quality issues associated with Columbia and Snake River operations.

The Water Quality Unit coordinates various sections of the annual TDG and Temperature Report with the Corps districts to prepare the final report, which is used to obtain TDG state variances.

The Water Quality Unit coordinates the water quality gauge functioning with the Corps districts to ensure that the real time water quality data is of good quality.

The Water Quality Unit coordinates with Hydrologic Engineering Branch (HEB) to ensure that water quality data is being entered into the CWMS database, web reports are being posted and data is available.

The Water Quality Unit coordinates with the Regional Forum Water Quality Team (WQT) on technical water quality issues that affect the Columbia River Basin river system. This activity includes technical exchange of information on TDG, building consensus toward common goals and technical approaches and peer review.

The Water Quality Unit coordinates the Dissolved Gas Plan of Action each year with the Regional Forum Water Quality Team. The Dissolved Gas Plan of Action is used by the Regional Forum Technical Management Team in making recommendations on the operation of the Federal Columbia River Power System for multi-purpose uses. The Plan stipulates what to measure, how, where, and when to take the measurements and how to analyze and interpret the resulting data. The Plan also provides for periodic review and alteration or reduction of efforts when monitoring results and/or new information from other sources justifies a change.

The Water Quality Unit coordinates various sections from NWD, Columbia Basin Water Management, Corps districts to prepare an Annual Water Quality Report that describes the water quality actions the districts and RCC Water Quality Unit performed.

The Water Quality Unit coordinates with various regional entities to update the Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers. This report describes both the short-term and long-term plans for the reduction of TDG and management of water temperatures.

The Water Quality Unit coordinates with EPA, the states and the tribes as they work on a combined approach to TMDL issues in the Columbia and Snake River mainstems. The Corps attempted to keep abreast of these issues and provide support where feasible.

3.3. Laboratory and Field Equipment and Technical Capabilities

The RCC Water Quality Unit does not have a Corps owned laboratory facilities, perform laboratory activities or collect samples that need analyses.

3.4. Regulation Changes

The National Wildlife Federation sued National Marine Fisheries Service and challenged the National Marine Fisheries Service (NOAA Fisheries) 2000 Biological Opinion (BiOp) on operation of the Federal Columbia River Power System for salmon and steelhead. In the May 7, 2003, federal court decision, Portland-based U.S. District Court Judge Redden found the 2000 Biological Opinion (2000 BiOp) for the Federal Columbia River Power System (FCRPS) did not adequately define the Action Area (the area affected by the federal hydro system) and did not adequately assure that offsite mitigation measures will occur. The court remanded the 2000 BiOp to NOAA Fisheries to correct the flaws.

On November 30, 2004 NOAA Fisheries issued a new biological opinion on operations of the Federal Columbia River Power System (2004 BiOp). The BiOp assessed the activities set forth in the Action Agencies (Corps, Bonneville, and Reclamation) Updated Proposed Action (UPA), November 24, 2004, upon which the revised biological opinion is based. The Final Biological Opinion and UPA were refined in response to comments received on NOAA Fisheries' draft Biological Opinion and the Action Agencies draft UPA. The Final Biological Opinion and UPA guide the 2005 spill and operations of the Federal Columbia River Power System.

3.5. Data Management Activities

The Northwestern Division, Columbia Basin Region serves as the data collection site for the water control and real-time water quality data, which includes data from fixed monitoring stations (FMS). At the present time, NWD Columbia Basin Region's water control and real-time water quality data are stored in two data management systems: the old system called Columbia River Operational Hydrological Management System (CROHMS), a HEC-DSS database and the new system called Corps Water Management System (CWMS), an Oracle data management system. The NWD, Columbia Basin Region is in the process of converting from CROHMS to CWMS. Once the conversion is complete, the CROHMS data management system will be discarded.

The RCC Water Quality Unit is on the Regional Pathname committee, which is renaming and reviewing all of the 27,000 pathname in CROHMS and CWMS. The Water Quality Unit is renaming and reviewing the water quality real time data pathnames to ensure they are named according to the agreed upon naming convention described in the data dictionary the NWD Pathname committee wrote. The Water Quality Unit is also attends the CROHMS/CWMS conversion meetings to ensure the Internet web reports are converted correctly and are complete. RCC Water Quality Unit uses internet web reports that have hourly total dissolved gas, water temperature, project flow and project spill data and these reports are posted on the Technical Management Team's homepage: http://www.nwd-wc.usace.army.mil/tmt/

The RCC Water Quality Unit established a NWD RCC Water Quality web page http://www.nwd-wc.usace.army.mil/TMT/wqwebpage/mainpage.htm where various kinds of information associate with the NWD water quality program are posted. The Plan of Action for TDG monitoring in 2004 and the Annual TDG and Temperature Report are among the documents posted at the website. The RCC Water Quality Unit ensures that various kinds of data and information are also posted to the regional Technical Management Team (TMT) homepage for dissemination to regional users and researchers.

The RCC Water Quality Unit prepares the Annual TDG and Temperature Monitoring Report, which include information on the spill program and TDG and temperature exceedances. The Annual TDG and Temperature Monitoring Report also includes information from the three districts in the Columbia River Region on the FMS data quality assurance and quality control. Refer to the Annual TDG Report for a summary of the FMS Program.

3.6. Water Quality Reports

Annually the Northwestern Division, Columbia Basin Region publishes a number of reports and the following is a list of them:

- The Annual Water Quality Report
- The Annual Total Dissolved Gas and Temperature Monitoring Report
- The Annual TDG Monitoring Plan of Action
- Total Dissolved Gas Management Plan
- Spill Cap Guidance Document

3.7. Meeting, Conferences and Training

The following is a list of the meetings and conferences that the water quality unit attended and participated in:

1. Water Quality Unit staff (Jim Adams, Laura Hamilton and Tina Lundell) attended weekly to biweekly in-house meetings of the Regional Forum Technical Management Team discussing flow augmentation and spill operations for the protection of endangered fish.

2. Jim Adams attended the monthly NOAA Fisheries Regional Forum Water Quality Team meetings concerning Total Dissolved Gas and water temperature.

3. Jim Adams attended the semi-annual Trans-boundary gas group meeting held in April 2004 at Stevenson Washington and in November 2004 at Penticton, BC.

4. Jim Adams held spring and fall TDG Monitoring Coordination Meetings with the Districts; Bureau of Reclamation, and the Public Utilities Districts.

5. Jim Adams and Laura Hamilton attended several meetings with Aquatic Informatics from October 2004 to December 2004 to discuss their software and its use to correct and validate Corps of Engineers data.

6. Laura Hamilton attends numerous in-house meetings on the CWMS transition and CWMS pathnames.

7. Laura Hamilton gave a speech on careers in Environmental Engineering with the Corps of Engineers at ASE (Advancement of Science and Engneering) Midsummer Conference Oregon State University, Corvallis OR on July 23, 2004.

3.7.1. Training Attended in FY04

The water quality unit attended several training classes and they were:

1. Jim Adams attended LEAD training in March 2004.

2. Jim Adams, Laura Hamilton and Tina Lundell attend SYSTDG training once a month from January through April 2004 in preparation of using the model during the 2004 spill season. The same staff also attended SYSTDG training in July and September as reviews of how the model worked and future improvements that are needed.

3. Laura Hamilton attended the Canada Water Resource Association Workshop at Vancouver, BC on October 12 through the 13th 2004. She made a presentation on the Corps' water quality data management and heard the latest developments in water quality research, monitoring and data management.

4. As a SCEP (Student Career Education Program) student, Tina Lundell took six engineering related classes and completed her Bachelors degree in Civil Engineering on June 11, 2004.

5. On July 26, 2004 Tina Lundell began a one-year Engineer-In-Training rotation among the various sections in the Portland District and NW Division office.

6. Jim Adams attended Committee on Water Quality August 30 through September 3, 2004

3.7.2. Required/Recommended Future Training for In-House Staff

The water quality unit plans to attend several training classes and they are:

1. Jim Adams will attend the Water Quality Seminar on May 9 – May 13, 2005.
2. Jim Adams will attend the Leadership for Learning on June 20 – June 24, 2005
3. Laura Hamilton will attend LEAD training on February 7-11, 2004.
4. Tina Lundell will attend the Intern Leadership Development Course (ILDC) on January 31– February 4, 2005

3.8. Personnel and Expenditures

During 2004, the RCC Water Quality Unit Water Quality Management Program consists of the following personnel:

Jim Adams:	Water Quality Team Leader, GS-13, 1 FTE.
Laura Hamilton:	Environmental Engineer, GS-12, 1 FTE.
Nancy Yun*:	Hydraulic Engineer, GS-12, ½ FTE.
Tina Lundell*:	Engineer In Training, GS-5, ½ FTE.

*Nancy Yun was performing duties as a hydraulic engineer until May 2004 when she retired from the Corps of Engineers. Tina Lundell graduated with a BS in civil engineering in June 2004 and has been on her 1 year Engineer In Training (EIT) rotation.

3.8.1. In House Expenditures

The RCC Water Quality Unit's main in-house expenditures was for traveling to meetings, conferences and training, which came to a total of approximately $5,000 for 2004.

3.8.2. Contracts

The Northwestern Division awarded no contracts in 2004.

3.9. Special Coordination with other Corps Entities

The Northwestern Division, Columbia Basin Region continues efforts with the Portland, Walla Walla and Seattle Districts, reviewing the current SYSTDG numerical modeling capabilities with a focus on how it serves the needs of the region in 2003.

3.10. NWD, RCC Water Quality Unit Summary

Spill management of the Columbia and Snake Rivers and beta testing the new SYSTDG model during the 2004 spill season went well. Although there are modifications that are needed to the model, it was a very useful tool for assisting with spill change decisions. The number and types of TDG and temperature exceedances were tracked during the 2004 spill season as they were in 2003. The use of SYSTDG model during the spill season appears to have reduced the number of type 6 TDG exceedances, which are exceedances credited to uncertainties when using best professional judgment to apply the spill guidance criteria (travel time; degassing; water temperature effects; spill patterns, etc). Although it is not possible to conclusive prove that type 6 exceedances are less during 2004 spill season because of using SYTDG, it is reasonable to suggest that it assisted in reducing the exceedances. The RCC Water Quality Unit was able to run many simulations with the SYSTDG model, but was not able to effectively modify the model input to reflect climate changes that the National Weather Service forecasts. This future improvement and others that RCC Water Quality Unit requested were discussed with Mike Schneider and Bonneville

Power Administration and are included in the statement of work for the SYSTDG model development for 2005. The draft version of the SYSTDG users manual with a step-by-step guide on how to use SYTDG in real time operations was very helpful to both the RCC Water Quality Unit and other regional users as supportive training materials.

The RCC Water Quality Unit coordinated with Walla Walla district, the Regional Forum Water Quality Team, Bonneville Power Administration and Mike Schneider on the RPA 132 proposal to move several forebay gauges so they are more representative of river conditions. The gauges that Walla Walla district proposes to move are all the Lower Snake River and McNary Dam fixed forebay TDG sites. Since lowering the gauges from 5 m to 12-15 m depth could affect the amount of spill for fish passage, Bonneville Power Administration was interested in discussing the impacts. Ongoing discussions are continuing.

During 2004, Bonneville Power Administration considered a proposal of releasing 100 KAF from Brownlee Reservoir for flow augmentation during July, which could result in raising the Lower Snake River water temperatures. Using the CE-QUAL-W2 model Dr. Michael Schneider from ERDC worked with the Water Quality Unit to simulate various scenarios to respond to the request for information from regional executives on whether this additional release from Brownlee wouldoffset to the effects of reduced spill at the lower Columbia River Dams later in the season.
During 2003 and 2004 spill seasons, the regional forum Technical Management Team asked for lower Dworshak water temperature releases than any that were previously provided, which was 48^{o}F. During 2003, the Dworshak water temperature releases were 45^{o}F for 7 weeks. During the 2004 spill season the Dworshak water temperature releases were 43^{o}F for 10 days and 45^{o}F for the rest of the spill season (10 weeks) until the water temperature gradually drifted up to 47^{o}F. The RCC Water Quality Unit sees the 2004 Dworshak cool water releases operation as a success because the mass and temperature balances provided answers to TMT's questions of how long 43 or 45^{o}F water releases could be maintained. Implementation of RCC Water Quality Unit's estimate showed that the estimates were correct. Because the mass and temperature balances used to address questions about Dworshak cool water releases is not as scientifically designed as what an adequately modified CE-QUAL-W2 model could produce, it is anticipated that the RCC, Water Quality Unit will eventually use the CE-QUAL-W2 model to make these estimates.

Since NWD Columbia Basin Water Management water control and real-time water quality data management system is being converted from the old CROHMS system to the new CWMS system, there are many changes necessary to make a successful conversion. The CROHMS/CWMS transition committee realized that several major activities needed to be undertaken, such as: create a pathname naming convention; write a data dictionary describing and giving guidance on how to implement the naming convention; and generate a master list of all pathnames found in CROHMS and what the new name would be in CWMS. The RCC Water Quality Unit participates in the CROHMS/CWMS transition and pathname committees, performing many tasks that would ensure all water quality data related issues are addressed in the CROHMS data management system conversion to CWMS.

4. Walla Walla District Activities

4.1. Introduction

The Walla Walla District project area includes; McNary Reservoir in the Mid Columbia River, 124 miles of reservoirs on the lower Snake River, Dworshak Reservoir and the Clearwater river system from Orofino to Lewiston, Idaho. Ongoing monitoring and evaluation of temperature and Total Dissolved Gas (TDG) measurements at district projects continued. Efforts were made to improve water quality sampling measures and obtain high quality data. The data is information relevant in controlling dissolved gas supersaturation in the river systems, and in identifying how management operations effect basin wide changes in dissolved gas saturation levels. Plans are to provide data to develop and enhance an operational water quality model. Work efforts continued in order to evaluate the effects of temperature differentials on fish passage. Alternative or corrective measures will be identified and tested as part of a multi phase plan. The following were objectives and goals for the district water quality program in fiscal 2004:

Objective 1. Manage data collection and operation of sixteen fixed-monitoring (FMS) stations (eight seasonal and eight year around) for total dissolved gas (TDG), barometric pressure (BP) and temperature. Stations are located in the dam tailwaters below Dworshak Dam, in the forebay and tailwaters at the four Lower Snake River dams, at McNary dam forebay and tailwater, and on the Clearwater River.

Objective 2. Pursuant to RPA-114 of the 2000 Federal Columbia River Power System Biological Opinion (FCRPS); temperature monitoring continued as part of the multi phase effort to physically characterize temperature regimes and determine effects of temperature differentials on fish passage. Corps biologist collected and evaluated temperature data in juvenile and adult fish passage facilities at McNary Dam on the Columbia River and on the Lower Snake River Dams at Lower Granite, Little Goose, Lower Monumental, and Ice Harbor.

Objective3. Pursuant to RPA-132 of the 2000 FCRPS; technical assistance was provided for a comprehensive review and evaluation of the total dissolved gas monitoring stations in Walla Walla District. Remedial action measures were identified to assure representativeness of data. Goals are to procure high quality objective data. This will support sound management decisions in the total dissolved gas program in order to achieve water quality compliance. Under RPA-131 redundant TDG monitors were placed adjacent to existing monitors at TDG stations at varying depths.

Objective 4. Pursuant to RPA-143 of the 2000 FCRPS Biological Opinion; technical assistance was provided for data collection strategies, with emphasis on evaluating water temperature effects from alternate river operations and in providing input to increase the predictive capabilities of a working model. Temperature was collected at various locations at

the Lower Snake River dams including dam forebays and tailwaters and a point mid section in each pool. In 2004, additional temperature sampling stations were set up in selected Snake River tributaries including the Tucannon, Palouse, Grand Rhonde and Salmon Rivers. Meteorological, discharge, and temperature data was summarized in the Lower Snake River Temperature Condition Report. Data evaluations were made based on heat flux and temperature variability. Water quality floats were placed in the forebays of the lower Snake River projects and Dworshak Reservoir that measure temperature at multiple depths using Apprise® technology. Data is transmitted hourly to the Columbia Basin Corps of Engineers CROHMS water management system (CWMS).

Objective 5. Corps Walla Walla District Biologist in Hydrology coordinated drinking water and wastewater management programs at Lower Granite and Little Goose Dams on the Lower Snake River. Fiscal 2004 activities included compliance testing, reporting, system performance evaluations and on site instruction for field office project personnel.

Objective 6. Corps Walla Walla District Biologist in Hydrology is tasked with providing water quality assistance to various departments within the district. Assistance was given to District Planning and Operations Sections. Water quality testing was conducted at several storm water retention ponds in Lewiston. Plans were formulated for a comprehensive water quality sampling of pumping plants to address regulatory and legal discharge issues in the Clearwater River Basin. Water velocities, and temperatures were measured at six sites for the Woody Riparian habitat study. Temperature was monitored at the Mill Creek Diversion structure and TDG, BP and temperature were monitored at the Pasco, Washington station in conjunction with evaluating various brands of water quality sampling equipment.

Objective 7. Walla Walla District provided technical assistance for a Clearwater, Snake and Columbia River Limnological Data Collection. Field data measured consisted of water column measurements for pH, temperature, dissolved oxygen, and conductivity. Data was sampled at two stations in the Columbia River, three stations in the Lower Snake River and two stations in the Clearwater River monthly from June through September. Additional parameters were measured from varying depths at the stations. Parameters sampled included alkalinity, ammonia-N, total Kjeldahl nitrogen, nitrite, nitrate, total phosphorous, total suspended solids, phytoplankton, zooplankton and chlorophyll a.

4.2. Water Quality Conditions, Data Collection/Analysis and Activities/Investigations.

The Walla Walla district water quality program activities during 2004 covered the Lower Snake River, Boise River, Mill Creek and the Lower Columbia River. The Lower Snake Projects include Lower Granite; Little Goose; Lower Monumental; and Ice Harbor. The Boise River has one project and it is Lucky Peak reservoir. Mill Creek activities include activities on the creek itself and Virgil B. Bennington Lake. McNary dam is the only project on the Columbia River that Walla Walla district manages. The following is the general overview of the water quality conditions, data collection/analysis and activities at these projects performed during 2004.

4.2.1. McNary Project and Reservoir

Reservoir temperature data proximal to forebays was collected in 2004 using Onset® temperature sensors during the continuing Review and Evaluation of TDG Forebay Fixed Monitoring Stations Study. Alternative sampling sites were evaluated. Results indicated that thermally induced spikes in TDG affected forebay TDG monitoring. This was attributed to near field hydrodynamics and vertical thermal gradients caused by a down welling of warmed surface water. The McNary Oregon station is located near the upstream face of the powerhouse and is being impacted by down welling of warmed surface water. The McNary Washington is located upstream of the project face with no vertical wall interference. However study results indicated that warming extended to 10 meters at both stations. Additionally there was no significant difference in data between the two forebay stations. Recommendations are to extend the sondes to a depth of 12-15 meters.

Temperature was monitored in the fish passage facilities from June 1 to September 30 at McNary and also at all of the Lower Snake River Hydropower Projects. This corresponded with the period having the greatest temperature differentials. The previous annual sampling regimes of seven months were deemed unnecessary. Several sampling locations were deemed not meaningful and were eliminated. In the McNary ladder system temperature differentials were about three degrees F between the counting station and first diffuser. Although this was not considered problematic it is the only ladder site among the eight project ladders studied that has been recommended for continued sampling.

Hourly measurements for TDG, BP and temperature were greater than 99 percent complete for the both FMS stations at McNary and also at all of the District stations on the Lower Snake and Clearwater Rivers. QA/QC records for field calibration revealed only minor differences between the in-place and replacement sondes with overall averages of –0.10 mm Hg for BP, 0.07 percent TDG saturation, and 0.003 degrees C at FMS stations District wide.

An acoustic doppler current profiling (ADCP) and temperature study was conducted in the forebay to support Computational Fluid Dynamics (CFD) numerical modeling. Thermal characteristics of the water passing through the trash racks in the gatewells, orifices and draft tube exits were monitored with temperature strings during the summer. Vertical thermistor strings were deployed and transects perpendicular to the river were monitored for temperature at locations of 100-ft, 500-ft, 1000-ft, 2500-ft, 5000-ft, 15000-ft and 20,000-ft upstream of the dam. Mobile ADCP sampling was performed at four transects in the spring and again in July.

A water velocity field study was conducted at McNary Dam Tailrace to support TDG modeling. Flow conditions were characterized using mobile and stationary boat ADCP sampling over three transects parallel to the powerhouse during concurrent spillway and powerhouse operations. Additional ADCP sampling was conducted at the ice and trash sluiceway to characterize powerhouse flow entering the stilling basin.

Limnological field water quality data was collected at Columbia River miles 295 and 326. Zooplankton and phytoplankton were identified and enumerated at sample sites.

A regulatory issue is being considered in regards to permitting a cooling water discharge the dam.

4.2.2. Ice Harbor Project and Reservoir.

Forebay temperature monitoring continued. Temperatures were also monitored mid pool, at the boat restricted zone buoy and face of the dam. Relocation of the forebay station to the upstream lock guidewall was recommended to avoid thermal induced pressure spikes. This would allow more representative sampling. Evaluation of temperature differentials is ongoing at the fishways. Ice Harbor adult fish passage facilities have not been identified as having significant temperature differentials. Information from multiple studies indicates a temperature gain from Lower Granite to Ice Harbor. This is noticeable particularly when releases at Dworshak Reservoir were being used to cool the Snake River.
At the dam, well number 2 is in predominant use as a water source but has characteristically high nitrates. Well number three is for emergency use. Nitrate levels are somewhat elevated at well three, being close to but below action levels. Considerations are being made to decide whether to designate well number three for potable water or implement water treatment measures. At Charbonneau Park potable water upgrade option is being considered in cooperation with Sun Harbor housing development.

Limnological field data was collected at Snake River mile 18 near Fishhook Park.

4.2.3. Lower Monumental Project and Reservoir

Temperature and TDG profiling in the forebay indicated thermal spiking of TDG associated with daily surface warming and downwelling. The downwelling occurs from turbine intakes nearby that operate during generation. Thermisters were placed in several forebay sights and midpool. Temperature profiling indicated that the forebay sights were sensitive to diel variability from April to September to a depth of 10 meters. Recommendations are to relocate the forebay TDG station upstream to the lock guidewall area.

Temperatures were rather uniform early and late in the season at the adult fish passage facilities. However pronounced temperature differentials (>5 degrees F) occurred in the summer months between the adult fishway downstream ends and upstream exit pools at Lo Mo North.

Temperature and water velocities were measured at high and low flow conditions at Ayer's basin and Magallon. These parameters are being evaluated for proposed salmon habitat improvements under the Woody Riparian study.

4.2.4. Little Goose Project and Reservoir

The forebay fixed TDG monitoring site was evaluated for temperature and TDG. Thermal spiking was apparent when comparisons were made to four self-contained remote automated logging units. This corresponded to TDG spikes of 3-4 percent in early June. Data from the 2004 temperature study indicated that the upstream lock wall appeared to be more representative of actual river temperatures. Recommendations were to relocate the forebay TDG station to the upstream lock guidewall. This would be more consistent with recommended locations for the other Lower Snake River forebay stations and free from dam face thermal influence.

Temperatures were rather uniform early and late in the season at the fish passage facilities. However pronounced temperature differential differentials (>5 degrees F) occurred at the adult fishway in the summer months between the downstream ends and upstream exit pools.

Temperature and water velocities were measured at high and low flow conditions at Beckwith and Swift Bar. These parameters are being evaluated for proposed salmon habitat improvement under the Woody Riparian study.

The District Hydrology section biologist met with a Washington Department of Health contracted employee to discuss best management practices for the Texas Rapids day use well. It is a Class B system and disinfection is not used at this well. Tests for drinking water have been consistently satisfactory. Measures discussed were structurally related. The Department of Health will probably make some of the recommendations statewide compliance measures at some future time. Wastewater effluent quality (suspended solids) was noticeably improved when pH was adjusted to near neutral in the sewage package plant aeration tank. Chlorine tablets used for disinfection appear to be effective and easier to use than hypochlorite solutions.

4.2.5. Lower Granite Project and Reservoir

Significant warming effects in the forebay produced TDG pressure spikes exceeding five percent saturation. The forebay studies indicated that these effects extended to a depth of 15 meters at Lower Granite. The forebay fixed monitoring TDG station is already positioned at the upstream lock guidewall at a depth of about 5 meters. Recommendations are to extend the fixed station depth to 15 meters.

The adult fishways at Lower Granite appear to be the most problematic on the basis of temperature differentials. During the summer months pronounced temperature differentials (> five degrees F) often occurred. Corrective measures are emphasized under this multi-phase study.

Walla Walla District Biologist managed the drinking and wastewater program at Lower Granite. Well two is being repaired and a temporary waiver was requested for inorganic

drinking water tests. Dissolved oxygen meters were calibrated with a high precision portable barometer. Oxygen is routinely monitored and adjusted in the wastewater system to maintain high quality effluents. District Biologist conducted several training sessions for project employees in regards to drinking water and wastewater. Compliance testing was performed. Test results and NPDES reports were forwarded to regulatory agencies.

Limnological samples were taken at Snake River miles 108 and 129 for a variety of water quality parameters. Sampling also included zooplankton and phytoplankton identification and enumeration. Samples were also taken in the Clearwater River between Clearwater River Miles 2 and 3.

4.2.6. Dworshak Project and Reservoir

Discharge and temperature data from 2004 RPA studies show that discharge from Dworshak dam during July, August and early September dominate the Clearwater river flows and influence water temperatures in the Lower Snake River. There have been routine releases of cool water from Dworshak during the summers since the early 1990s. This appears to benefit fish migration with fall chinook and steelhead staying in the cooler lake strata. During that period while cooling the Clearwater River a steep vertical temperature gradient is produced. Cooler water from releases does not appear to mix with warmer reservoir water except at the turbines and tailwaters immediately below the dam. The thermal layering reappears and persists through the next reservoir. Temperature layering effects are occurring that can directly influence entrance and exit pool temperature in the adult fishways. There are indications from the adult fishway studies that the effects from Dworshak may be exacerbating temperature differentials.

Continuing study phases will examine biological effect on fish passage and alternative measures such as introducing cooler water into the fish ladders.

Temperatures have been recorded about 0.4 degrees C higher over a six week springtime period when monitored at a study site on the opposite bank across from the tailwater fixed TDG monitoring site at Dworshak. In 2004 a pipe breakage resulted in a temporary relocation of the station a short distance away. Dworshak tailwater is the only Walla Walla District TDG station where a cross field study has not been done. Two fish hatcheries draw water from Dworshak tailwaters at variable rates. Based on the importance of Dworshak as a water resource it is recommended that a study be conducted measuring variability in flow and temperature seasonally and over a range of discharges. This would aid in determining any bias present, provide information to determine if station relocation is necessary and contribute to a working model.

As part of an ongoing temperature monitoring program in Dworshak Reservoir thermistors are in place at six reservoir and eight stream (creek inlets) sites. In 2004 temperature data was downloaded. Five reservoir arrays were repaired and necessary repairs were made at the stream stations.

A water quality float in the forebay of Dworshak Reservoir measures temperature at multiple depths using Apprise® technology. Data is transmitted hourly to the Columbia Basin Region Corps of Engineers CROHMS water management system (CWMS).

4.2.7. Mill Creek and Virgil B. Bennington Lake

Dissolved oxygen, temperature, pH, and conductivity were monitored from December of 2003 to June 2004 at the Mill Creek Diversion Structure. Temperatures were also monitored in the pool just upstream of the structure.

4.2.8. Lucky Peak Reservoir (Boise River).

Robie Creek Beach was closed for four days in early July due to coliform bacteria.
No routine water quality activities were conducted at this project. Most of the identified water quality problems associated with the Boise River occur downstream and independent of the project.

4.2.9. Lewiston Levees

Water quality parameters were sampled in Pump Plant A, a storm water retention pond in Lewiston, Idaho. Test results indicated that there appeared to be no significant enrichment from a runoff pipe on the west side of the pond. A sonic resonator was used as an aquatic weed control measure starting in late June. Plans were formulated for water quality testing of all four pump plant ponds in response to regulatory and legal discharge issues.

4.2.10. TDG fixed monitoring program

The U.S. Army Corps of Engineers Walla Walla District operated sixteen fixed monitoring-stations (eight seasonal and eight year-round) for total dissolved gas (TDG), barometric Pressure (BP), and temperature as part of the 2004 water quality program.
These stations are located on the Columbia, Lower Snake and Clearwater Rivers. Field instrument calibration revealed only minor differences between the in-place and replacement sondes with overall averages of –0.10 mm HG for BP, 0.07 percent TDG saturation and 0.003 degrees C. The hourly measurements for all three parameters were greater than 99 percent complete.

4.3. Laboratory and Field Equipment and Technical Capabilities

Walla Walla district water quality program requires various types of lab analysis, field equipment and technical expertise. The following is a description of how these needs are met.

Walla Walla District maintains the capacity to collect water and sediment samples throughout the Division. Equipment available includes:

a. A two-man canoe.
b. An 18-ft river jet boat and motors.
c. One 23-ft, GPS equipped aluminum work vessel.
d. A Ford F350 super duty service body truck (GSA).
e. Two acoustic doppler profilers.
f. Seventy-five water quality multi-probe profilers.
g. Comprehensive groundwater sampling apparatus, including submersible pumps, plus biological sample and analysis equipment.
h. Sediment Ponar and core samplers, winches and other related instruments and equipment.

Walla Walla District enhanced the capability of its modest water quality laboratory facility. Features include:

a. Instruments for calibration of field sondes and completion of necessary QA/QC for TDG instrumentation. A NIST certified barometer and certified pressure sources insure that the TDG instrumentation is kept at optimal performance.
b. A comprehensive suite of equipment to maintain and repair Hydrolab®andYSI®, TDG and water quality data collection equipment. A special 2-HP electric mixer can maintain a constant water temperature bath when used during calibration and instrument evaluation.
c. The water quality laboratory has the capacity to analyze nutrient samples from the district reservoirs. Parameters include phosphorus, nitrate, ammonia, sulfate, total nitrogen, chlorophyll *a*, plus selected anions and cations.

The laboratory can also support a variety of turbidity monitoring equipment in support of dredging and construction operations. A full complement of sieves, ovens, shakers, and cabinets allow for volume production of particle-size grain analysis along with other selected qualitative and quantitative sediment analyses.

The laboratory also monitors and maintains contracts for the analysis of metals and organic contaminants in support of District missions. The laboratory has detailed apparatus for the evaluation of most wastewater parameters. .

In 2004 The District acquired two replacement barometers, ten Hydrolab® minsondes and four Greenspan® Multi Probes for water quality monitoring. We have an inventory of eleven pontoons for water quality monitoring. Five of these are equipped with temperature thermister strings and Sutron® data loggers for real time data and satellite transmission and are currently placed at project dam forebays. We have a requisition in place to procure a Digiquartz® Portable Laboratory high precision Barometer. Equipment is purchased by requisition as needed contingent on funding availability.

4.4. Regulation Changes

No new regulations were created at the District level.

4.5. Data Management Activities

The Walla Walla district water quality program is managing water quality data with current technology, which includes the following actions:

- Greg Hernandez a Hydrology section employee in engineering received STORET training.
- The Walla Walla District Corps of Engineers are in the process of transferring discreet water quality field data from DASLER to STORET.

4.6. Water Quality Reports

Walla Walla district water quality staffs wrote, coordinated or contracted to have written several major reports associated with various water quality activities, and the following is a list of them:

- Army Corps of Engineers, Walla Walla District 2004. Water Temperatures in Adult Fishways at Mainstem Dams on the Snake and Columbia Rivers: Phase 1-Physical Characterization.

- Rex Baxter, 2004 Walla Walla District Biologist. Water Temperature Monitoring Program for Adult and Juvenile Fish Facilities in the Walla Walla District.

- OA Systems Joe H. Carroll for Walla Walla District Corps of Engineers. December 2003. TDG Forebay Fixed Monitoring Station Review and Evaluation for Lower Snake River Projects and McNary Dam.

- OA Systems for Walla Walla District Corps of Engineers. December 2004.
- Lower Snake River Temperature Conditions 2003.

4.7. Meetings, Conferences and Training.

Steve Juul presented a seminar at ERDC in Vicksburg, Mississippi regarding water quality issues in the Northwest. Phil Fishella instructed drinking and wastewater testing sessions for Corps employees at Lower Granite Dam. Phil Fishella corresponded in telephone conference meetings as a chemical committee member for the Regional Sediment Evaluation Team.

Russ Heaton was deployed to Iraq in the National Guard for most of fiscal 2004.

4.7.1. Training Attended in FY04

Steve Juul attended; a Regional Flood Control Workshop in Portland, Oregon, Hyperspectral Imagery presentations in Portland and Boise, Water Quality Team Meetings in Portland, and a Hydrologic and Hydraulic Considerations Planning Course.

Steve Juul and Phil Fishella attended the Regional Sediment Evaluation Team Meeting in Lewiston, Idaho.

4.7.2. Required/Recommended Future Training for In-House Staff

The following is a list of future training that in-house staffs plan to take:

- A STORET class will be requested as future training for Phil Fishella.

4.8. Personnel and Expenditures

4.8.1. In House Expenditures

The Walla Walla District's Water Quality Management Program consists of the following personnel:

Steve Juul:	Water Quality Specialist, GS-12, 1 FTE.
Russ Heaton:	Limnologist, GS-11, 1 FTE..
Phil Fishella:	Limnologist, GS-11, 1 FTE.

The Walla Walla District Hydrology water quality section employs a water quality specialist and two limnologists. They have over 15 years experience in the limnology and water quality related fields. The staff has technical expertise in; watershed assessments, TDG and water quality monitoring system design and analysis, instream flow incremental methodology, lake and stream restoration, hazardous materials, aquatic plant management, fish management, wetland ecology, wastewater and drinking water management.

4.8.2. Contracts

The Walla Walla district contracts are summarized in the Table 1:

Table 1
Walla Walla District Contracts for 2004

Contract	Project	Amount
OA Sytems of Amarillo, TX	RPA 132 Review of Forebay Monitoring Study	66,964
OA Sytems of Amarillo, TX	RPA 143 Temperature Modeling Study	379,620
OA Sytems of Amarillo, TX	Water Velocity/ Temperature Study at McNary Dam Forebay	222,772
OA Sytems of Amarillo, TX	Lower Monumental Near-Field Study	57,057
ERDC - Vicksburg, MS	RPA 143 Temperature Modeling Study	247,000
ERDC - Vicksburg, MS	Lower Monumental Near-Field Study	15,000
USGS - Pasco, Wa	Routine system maintenance of FMS	395,000
	Other WQ expenditures	238,000
	Water temperature data collection	8,200
	FMS station equipment repair/ replacement	61,075
	RPA 143 field equipment	17,812
Total Contract Costs		**$1,708,500**

4.9. Special Coordination with other Corps Entities.

Mike Schneider of the Corps of Engineers ERDC was involved in scopes of work for RPA 143. Mike also is working on a report for RPA-133, a system wide TDG gas model for spill management, which is currently in draft form.

4.10. Walla Walla District Summary.

Hourly TDG, temperature, and barometric data were recorded during the 2004 water year at 16 FMS stations. Half of the stations were operated throughout the year and the other half were monitored from 1 April to 15 September. Field instrument calibration revealed only minor differences between the in place sonde and replacement sondes. Hourly barometric pressure, TDG. and temperature data were greater than 99 percent complete at all stations. Total gas saturation did not exceed 125 percent at any TDG station between 1 April and 15 September.

Water temperatures were physically characterized in the ongoing Adult Lower Snake River Dam Fishways Study. The fishways at Lower Granite, Little Goose and Lower Monumental North were emphasized for corrective measures in the multi-phase study. This was due to frequently occurring temperature differentials during summer months of greater than 5 degrees F between the downstream ladder entrance and the exit pools. In the 2004 calendar sampling period was refined and some inconsequential stations were eliminated or relocated.

In efforts to provide high quality data and improve the TDG system, representativeness of existing TDG fixed forebay monitors were evaluated. Thermally induced TDG pressure

spikes were observed at all the Lower Snake River and McNary Dam fixed forebay TDG sites. This was attributed to a downwelling of warm surface waters related to the dam face (near field) hydrodynamics. Recommendations are to relocate forebay monitors upstream to the end of the lock guidewall at Ice Harbor, Lower Monumental and Little Goose. The fixed forebay monitor at Lower Granite and McNary Oregon should be placed deeper, to depths of about 12-15 meters to avoid temperature layering. These changes should improve project management for TDG and provide for more accurate water quality compliance evaluations.

Lower Snake river temperature studies continued in 2004. Additional sampling stations were set up in Lower Snake River tributaries at the Tucannon, Palouse, Grand Rhonde and Salmon Rivers. Temperatures were collected at various locations including dam forebays, tailwaters and mid pool sections. Meteorological, discharge, and heat flux conditions were summarized in the Walla Walla District report. Information was generated that can be used to evaluate alternative river operations and to increase the predictive capabilities of a working model. The Salmon River significantly effects heat flux in the Lower Snake River cooling the river in the late spring and fall while causing the temperatures to rise in July.

Recommendations were made for relocation of the USGS station at Orofino because it was being impacted by a small flow just upstream of the sensor. Additional location recommendations were made in regards to improving USGS temperature collection sites at Peck and Spalding in the Clearwater River. Dworshak Dam releases were shown to provide a significant cooling effect on the Clearwater and Lower Snake River temperatures.
In reservoir and stream site temperature station data was downloaded from arrays at Dworshak Reservoir. Station equipment was replaced or repaired as needed.

Due to pipe breakage a new fixed TDG station will have to be installed in the North Fork of the Clearwater below Dworshak dam. A comprehensive study is recommended to determine dimensional variability in flow, TDG and temperature from just downstream of Dworshak dam to the fixed monitor site. This information will be used to assess project operations and to estimate sampling bias for the station.

A 2004 McNary dam temperature and velocity data collection study was performed in support of a McNary Dam forebay (CFD) numerical model. Thermal gradients were characterized, laterally, vertically and longitudinally for up to 20,000-ft upstream of the dam at McNary Reservoir. ADCP sampling was also completed at four transects.
A water velocity study was conducted at McNary dam tailrace to support TDG modeling. Flow conditions were characterized by ADCP sampling during concurrent spill and powerhouse operations.

Conventional water quality data was collected in a 2004 Clearwater, Lower Snake and Columbia River limnological data collection. Parameters sampled included chlorophyll a, zooplankton and phytoplankton.

Temperature and velocities were measured at several off channel areas in Little Goose and Lower Monumental Reservoirs during the Woody Riparian Study. An important finding was that velocities were less than 1 foot per second near the shorelines even during high flows.

Water and wastewater compliance testing was performed at Little Goose and Lower Granite projects.

The 2004 water year was the fifth consecutive year with flows below the 34912 K Acre-feet average as measured at Lower Granite Dam. Flows into the Lower Snake River for 2004 at Lower Granite were 26109 K acre-feet.

5. Seattle District Activities

5.1. Introduction

The Hydraulics and Hydrology Section of the Technical Services Branch run the Seattle District's water quality management program. The program is designed to monitor water quality at Seattle District projects and in waters located within the Seattle District's boundaries. Objectives and goals of the water quality management program include, but are not limited to:

Define baseline water quality conditions for each project.
Establish and maintain a water quality monitoring and data evaluation program that ensures achievement of water quality management objectives and to evaluate project performance and water quality trends.
Identify existing and potential water quality problems, and develop and implement appropriate solutions.
Maintain coordination, communication, and collaboration with all interested government and nongovernmental entities with regard to activities that may affect or be affected by water quality or water control decisions.

To meet the objectives and goals listed above, the Seattle District Hydraulics and Hydrology Section performs routine water quality data collection and evaluation at district projects, implements special studies and research projects, and coordinates monitoring efforts with local, state, and federal agencies. The water quality management program fiscal year 2004 objectives and goals are summarized below.

Continue routine water quality sampling at Libby Dam (Lake Koocanusa and the Kootenai River) and Howard Hanson Dam (Howard Hanson Reservoir and the Green River).

Continue real-time data collection of temperature and salinity in the Lake Washington Ship Canal to assist in operational decisions of the locks for control of saltwater intrusion into Lake Washington.

Continue real-time data collection system of hydrological, meteorological, and water quality data at rivers and reservoirs throughout Washington, Northern Idaho, and Western Montana.

Continue a fish hatchery water quality study at Chief Joseph Dam to characterize the quality of relief tunnel, forebay, and irrigation well waters to determine if these water sources meet water quality criteria for use at a proposed Colville Tribe fish hatchery.

Continue the temperature study at Libby Dam forebay to assess the accuracy of the automated temperature string on the face of the dam. Accurate readings are imperative for the selective withdrawal system and management of downstream water temperatures.

Continue to work together with the Bureau of Reclamation to implement joint operations between Grand Coulee Dam and Chief Joseph Dam to reduce total dissolved gas levels on the Columbia River system.

Continue to provide water quality and hydraulic expertise and support in the design and installation of flow-deflectors at Chief Joseph Dam to reduce TDG levels.

Continue to monitor total dissolved gas (TDG) at five (5) permanent sites located at the forebay and tailwater of Chief Joseph Dam, the forebay and tailwater of Albeni Falls Dam, and the tailwater of Libby Dam.

Continue to monitor water quality data at the East Bay Marina, Olympia Harbor, in South Puget Sound. Data is reviewed to determine when the Port of Olympia must operate its mechanical aeration system to increase dissolved oxygen levels to levels that are not harmful to fish.

Continue the water column temperature study at Chief Joseph Dam to evaluate water temperature increases in Lake Rufus Woods between Grand Coulee Dam and Chief Joseph Dam.

Continue a total dissolved gas management study at Libby Dam to provide a feasibility assessment of various structural and operational alternatives to allow higher flows past the dam while reducing TDG saturations in the Kootenai River below the dam.

Complete the water column temperature study at Chief Joseph Dam to evaluate water temperature increases in Lake Rufus Woods between Grand Coulee Dam and Chief Joseph Dam.

Complete the 2003 total dissolved gas exchange study at Albeni Falls Dam to evaluate TDG in the Pend Oreille River during various spill conditions.

Install permanent TDG monitoring stations at the forebay and tailwater of Albeni Falls Dam to monitor the impact of dam operations on the Pend Oreille River.

Update water quality instruments for the Lake Washington Ship Canal data collection program.

Implement a water quality study at Chief Joseph Dam to establish baseline information on the physical, chemical, and biological condition of Lake Rufus Woods and the Columbia River.

Implement a sediment quality study at Chief Joseph Dam to establish baseline information on the physical and chemical condition of sediments in Lake Rufus Woods.

Implement a water temperature study upstream and downstream of Albeni Falls Dam to establish baseline information for the Pend Oreille River system and Lake Pend Oreille for future TMDLs, and to study how Albeni Falls Dam may impact the Pend Oreille River system.

5.2. Summary of Water Quality Conditions, Data Collection/Analysis and other Activities/Investigation

The Seattle District water quality program activities during 2004 covers the Columbia River, Kootenai River, Pend Oreille River, Green River, White River, Chehalis River, and the Lake Washington Ship Canal. Chief Joseph Dam and Lake Rufus Woods are located on the Columbia River. Libby Dam and Lake Koocanusa are located on the Kootenai River. Albeni Falls Dam and Lake Pend Oreille are located on the Pend Oreille River. Howard Hanson Dam and Reservoir are located on the Green River. Mud Mountain Dam is located on the White River. Wynoochee Dam and Reservoir are located on the Wynoochee River. The Hiram Chittenden Locks are located on the Lake Washington Ship Canal. The following is the general overview of the water quality conditions, data collection/analysis and activities performed at these projects during 2004.

5.2.1. Chief Joseph Dam and Lake Rufus Woods

5.2.1.1.Water Quality Conditions and Issues

Current Conditions: Good
Current Issues: Total dissolved gas, temperature
Historical Problems: Total dissolved gas, temperature
Future Problems: Temperature, TDG, nutrients, algae, macrophytes

5.2.1.2.Data Collection and Analysis

The District continued real-time monitoring of total dissolved gas and temperature at forebay and tailwater fixed monitoring stations during the spill season from April 1 to September 15, 2004.

The District implemented a water quality monitoring program in 2004. Water quality grab samples were collected at monthly intervals in Lake Rufus Woods at three stations

from February through November. Water column composite samples were analyzed for conventionals, nutrients, and metals. Photic zone composite samples were analyzed for chlorophyll a and phytoplankton, while a ten (10) meter vertical tow was analyzed for zooplankton. Vertical profiles of temperature, dissolved oxygen, pH, and conductivity were recorded at each station. A downstream station on the Columbia River was monitored at monthly intervals, with samples being analyzed for conventionals, nutrients, and metals. Water quality monitoring will establish baseline information on the physical, chemical, and biological condition of Lake Rufus Woods and the Columbia River, and will better define the relationship between Chief Joseph Dam and the water quality in the Columbia River.

The District implemented a sediment quality monitoring program in 2004. Sediment samples were collected at five (5) stations in Lake Rufus Woods between Grand Coulee Dam and Chief Joseph Dam. Samples were analyzed for metals, organics, and particle size. An understanding of Lake Rufus Woods' sediment quality is important because studies conducted during the past two decades have shown substantial sediment contamination of Lake Roosevelt and the upper Columbia River with metals. The Washington State Department of Health has issued a health warning to the public on consumption of fish from Lake Roosevelt due to high mercury concentrations in fish tissue. Moreover, future sediment Total Daily Maximum Loads (TMDLs) for several trace metals may be implemented by the Washington State Department of Ecology (Ecology) and the United States Environmental Protection Agency (EPA) for Lake Roosevelt and the upper Columbia River. Baseline sediment quality data will help the Seattle District define the relationship, if any, between contaminated sediments in Lake Roosevelt upstream of Grand Coulee Dam and sediments in Lake Rufus Woods, upstream of Chief Joseph Dam.

The District continued a temperature study of Lake Rufus Woods in 2004. The purpose of the study was to determine changes in water column temperature in Lake Rufus Woods between Grand Coulee Dam and Chief Joseph Dam. Three temperature strings were deployed in the reservoir between Grand Coulee and Chief Joseph. Temperature strings consisted of Vemco data loggers attached at various depths to a weighted cable and secured in place with an anchor and buoy. Temperature was recorded hourly.

5.2.1.3.Research and Development

None during 2004.

5.2.1.4.Special Studies

The Seattle District conducted a baseline water quality assessment of fish hatchery water sources at Chief Joseph Dam during the 2004 water year. Potential sources of water identified for this study include the relief tunnel, the irrigation inlet structure located near the right bank in the forebay, and an irrigation well located along the right bank at Bridgeport State Park about one-half mile upstream of the dam. The fish hatchery would utilize one or more of these sources of water during the entire year to meet the quantity and quality of water needed for hatchery operations.

The quality of the proposed hatchery source water is important because water quality can determine the success or failure of fish hatchery operations. Historical sampling conducted in 1989 and 1990 at the relief tunnel detected mercury and nitrite in concentrations exceeding Washington State Department of Fish and Wildlife recommended water quality criteria for aquaculture programs. Consequently, the Colville Tribe expressed concerns about the quality of the relief tunnel and orientation water system wells water for hatchery operations. To address these concerns, the Seattle District designed a water study to quantify more precisely the water quality of all potential water sources for the fish hatchery.

The Seattle District finalized a study that evaluated joint operations of Chief Joseph Dam and Grand Coulee Dam. The study concluded that joint operations could lower TDG in Lake Rufus Woods. The District presented the results to the Technical Management Team, who then incorporated the result into the water quality plan.

The Seattle District participated in the design, modeling and water quality evaluation of flow deflectors at Chief Joseph Dam. Deflector construction is scheduled to begin in 2005 and to be completed by 2008. The Seattle District has worked together with the U.S. Army Corps of Engineers Engineering Design Research Center on a hydraulic model for the design of the flow deflectors. In addition, the district has overseen construction specifications to assure that state, tribal, and federal water quality criteria will be met during deflector construction.

5.2.1.5.Coordination with Other Agencies

The Seattle District worked together with the Confederated Tribes of the Colville Reservation to design and implement a water quality study of source waters for a potential fish hatchery to be located at Chief Joseph Dam.

The Seattle District worked together with the Bureau of Reclamation, the Bonneville Power Administration, National Marine Fisheries, the Colville Confederated Tribe, and the Washington Department of Ecology on implementing joint operations of Grand Coulee Dam and Chief Joseph Dam in order to reduce TDG in the Columbia River.

5.2.1.6.Scheduling for Project Evaluations

During 2005, water quality and sediment quality data collected during 2004 will be evaluated and a water quality monitoring report completed.

During 2005, temperature data collected in Lake Rufus Woods in 2002, 2003, and 2004 will be evaluated and a water quality monitoring report completed.

5.2.1.7.Problems with Contracted Work

No problems with contracted work occurred at Chief Joseph Dam.

5.2.1.8.Innovative Techniques to Improve Water Quality

Joint operations between Grand Coulee and Chief Joseph Dam were investigated in order to reduce TDG levels. A study conducted by the National Marine Fisheries (NMFS) Water Quality Team (WQT) subgroup concluded that reductions to total dissolved gas (TDG) saturations could be achieved in the Mid-Columbia River through joint operations of Grand Coulee Dam and Chief Joseph Dam. The study investigated the consequences of TDG saturation in the Mid-Columbia River from spilling via the outlet works at Grand Coulee Dam versus spilling via the existing spillway (no flow deflectors) at Chief Joseph Dam. The evaluation of water quality benefits were based on reducing TDG saturation above and below Chief Joseph Dam while maintaining a constant joint power output from both projects. Empirical equations were used to estimate the TDG exchange and power production from both projects subject to various background TDG levels, river flows, and power scenarios.

Installation of flow deflectors at Chief Joseph Dam to reduce TDG contributions from Chief Joseph dam. During 2004, the Seattle District completed the modeling and evaluation of deflector designs for the installation of flow deflectors on all 19 spillway bays at Chief Joseph Dam. The district developed construction sequences for the upcoming 2005 construction season to reduce water quality impacts from possible spill events that may occur during deflector construction.

5.2.2. Libby Dam and Lake Koocanusa

5.2.2.1.Water Quality Conditions and Issues

Current Conditions:	Good
Current Issues:	Total dissolved gas, temperature
Historical Problems:	Nutrients, metals, temperature
Future Problems:	Temperature, TDG

5.2.2.2.Data Collection and Analysis

Water quality monitoring at Libby Dam and Lake Koocanusa continued during 2004. Water quality grab samples were collected at monthly intervals in Lake Koocanusa at three stations between the international border and the forebay from April through November. Samples collected from the epilimnion and hypolimnion were analyzed for conventionals, nutrients, and metals. A composite sample from the photic zone was analyzed for chlorophyll a and algae. Vertical profiles of temperature, conductivity, pH, and dissolved oxygen were also recorded at each station. A downstream station on the Kootenai River was monitored at monthly intervals from January through December, with samples being analyzed for conventionals, nutrients, and metals. A temperature string was set up in the forebay. The string consisted of Vemco data loggers attached to a weighted cable. The temperature string logged hourly temperature at various depths between the surface and bottom of the reservoir.

The District continued real-time monitoring of total dissolved gas and temperature at the tailwater fixed monitoring station during the spill season from April 1 to September 15, 2004.

5.2.2.3.Research and Development

None during 2004.

5.2.2.4.Special Studies

The District conducted a total dissolved gas management study at Libby Dam to provide a feasibility assessment of various structural and operational alternatives that could increase flows released from Libby Dam and reduce TDG in the Kootenai River below the dam.

A temperature study of Lake Koocanusa continued in 2004. The purpose of the study was to examine the thermal properties in the forebay to aid in determining Libby Dam release temperatures that would benefit downstream sturgeon populations. A single temperature string was deployed in the forebay consisting of Vemco data loggers attached at various depths between the surface and bottom of the reservoir. Temperature was recorded every hour from April through November 2004.

5.2.2.5.Coordination with Other Agencies

Coordinated with the USGS to collect water quality data at Libby Dam, Lake Koocanusa, and the Kootenai River.

5.2.2.6.Scheduling Evaluations

During 2005, water quality data collected between 1975 and 2004 will be evaluated and the results summarized in a report.

5.2.2.7.Problems with Contracted Work

No problems with contracted work.

5.2.2.8.Innovative Techniques to Improve Water Quality

A total dissolved gas abatement study was completed in 2004. The results will be used to develop structural and operational changes at Libby Dam to enable higher flows to be passed while reducing TDG saturations in the Kootenai River.

5.2.3. Albeni Falls Dam and the Pend Oreille River

5.2.3.1.Water Quality Conditions and Issues

Current Conditions: Good
Current Issues: Temperature, TDG
Historical Problems: Temperature, metals
Future Problems: Temperature, TDG, nutrients, metals, macrophytes

5.2.3.2.Data Collection and Analysis

The District implemented real-time monitoring of total dissolved gas and temperature at forebay and tailwater fixed monitoring stations during the spill season from April 1 to September 15, 2004.

5.2.3.3.Research and Development

None during 2004.

5.2.3.4.Special Studies

The Seattle District implemented a two year temperature study of Lake Pend Oreille and the Pend Oreille River system during 2004. Temperature monitoring is needed to establish adequate baseline information for the Pend Oreille River and Lake Pend Oreille during the summer months. This data will allow the Seattle District to define the potential relationship between Albeni Falls Dam operations and the temperature in the Pend Oreille River system upstream and downstream of the dam. An understanding of the possible impact of Albeni Falls Dam operations on the temperature in the Pend Oreille River system is of paramount importance because of the proposed Pend Oreille River Total Daily Maximum Load (TMDL) for temperature that may be implemented by the Washington State Department of Ecology (WDOE), the Idaho Department of Environmental Quality (IDEQ) and the United States Environmental Protection Agency (EPA). Baseline data will allow the Seattle District to share data and work together with these agencies to develop a meaningful Pend Oreille River temperature TMDL.

The objective of the monitoring program is to determine (1) the existing temperature of tributaries to Lake Pend Oreille and the Pend Oreille River, (2) the existing temperature regime in Lake Pend Oreille, and (3) the existing temperature in the Pend Oreille River upstream and downstream of Albeni Falls Dam. To meet the project objectives described above, automated thermal loggers were deployed at several stations in the Lake Pend Oreille and Pend Oreille River watershed, including the Clark Fork River, Lightning Creek, Pack River, and the Priest River. All temperature data was collected using Vemco Minilog and Onset StowAway automated thermal loggers programmed to record date, time and temperature in degrees Celsius every hour. Temperature loggers were deployed in May of 2004 and retrieved in November of 2004. Similar deployment periods will occur in 2005.

A TDG exchange study was completed at Albeni Falls Dam. Monitoring in 2003 consisted of measuring TDG at 11 locations – 3 in the forebay, 3 immediately below the dam and 5 about 1.6 miles below the dam during spill that occurred from May 1 through June 30, 2003. Work in 2004 consisted of data analysis and interpretation. A draft report completed in 2004 defined and quantified processes that contribute to dissolved gas transfer during spill releases at Albeni Falls Dam. The report focused on resolving questions regarding accurate source and sink descriptions of mass conservation of dissolved gases in the Pend Oreille River below the dam.

5.2.3.5.Coordination with Other Agencies

Seattle District worked in conjunction with the Washington Department of Ecology and the Idaho Department of Environmental Quality to monitor water temperatures in the Pend Oreille River system for the development of a future temperature TMDL.

5.2.3.6.Scheduling Evaluations

During 2005, (1) a final report of the 2003 Total Dissolved Gas Exchange Study at Albeni Falls Dam will be competed, and (2) temperature and total dissolved gas data collected during 2004 will be compiled and evaluated.

5.2.3.7.Problems with Contracted Work

No problems with contracted work.

5.2.3.8.Innovative Techniques to Improve Water Quality

None during 2004.

5.2.4. Howard A. Hanson Dam and the Green River

5.2.4.1.Water Quality Conditions and Issues

Current Conditions: Good
Current Issues: None
Historical Problems: Temperature, turbidity
Future Problems: Temperature, turbidity, nutrients, algae

5.2.4.2.Data Collection and Analysis

Water quality samples were collected at Howard Hanson Reservoir from April through October 2004. The goal of the monitoring program was to characterize the water quality of Howard Hanson Reservoir during a normal water storage year to establish baseline conditions from which determination of potential water quality impacts from future elevated reservoir storage conditions can be assessed. Specifically, there was concern about the potential for increased reservoir elevations to lead to increased concentrations of nutrients, organic matter, and phytoplankton in the reservoir. To meet the project goals, water quality was monitored from one upstream river station and two in-reservoir station every three weeks during normal pool elevations. Water quality parameters of concern included temperature, dissolved oxygen, nutrients (i.e.

phosphorus and nitrogen), organic matter, chlorophyll a, and phytoplankton. Additional water quality parameters such as pH, conductivity, and alkalinity were monitored to help with the basic understanding of the limnology of the reservoir.

5.2.4.3.Research and Development

None during 2004.

5.2.4.4.Special Studies

None during 2004

5.2.4.5.Coordination with Other Agencies

Coordinated with Tacoma Public Utilities to monitor water quality at Howard Hanson Reservoir.

5.2.4.6.Scheduling Evaluations

During 2005, the Seattle District will compile and evaluate water quality data collected between 2002 and 2004.

5.2.4.7.Problems with Contracted Work

None during 2004.

5.2.4.8.Innovative Techniques to Improve Water Quality

None during 2004.

5.2.5. Lake Washington Ship Canal and Hiram Chittenden Locks

5.2.5.1.Water Quality Conditions and Issues

Current Conditions: Fair
Current Issues: Saltwater intrusion
Historical Problems: Saltwater intrusion, contaminated sediments
Future Problems: Contaminated sediments, benthic oxygen demand

5.2.5.2.Data Collection and Analysis

The Seattle District is responsible for the Lake Washington Ship Canal (LWSC) water quality monitoring program. The goal of this program is to monitor saltwater intrusion into the LWSC to ensure that lock operations do not result in exceeding the Washington Department of Ecology 1 part-per-thousand salinity water quality criteria at the University Bridge. The data collected may also be used in the future for modeling of the interaction and effects that the locks have on Lake Washington and Lake Union. The program collects hourly readings from several depths at five different locations from April through October. The sensors are calibrated in the field monthly to ensure proper readings. They are then removed from November through March when flows are highest and there is no risk of saltwater encroachment on Lake Washington. From

November through February sensors are cleaned and repaired. Sensors are calibrated in March to ensure proper function before deployment in April.

5.2.5.3.Research and Development

Water quality loggers were installed in Shilshole Bay downstream of the locks and fish ladder to collect vertical profiles of salinity and temperature from June through September 2004. Seattle District fishery biologists used these data for researching the movement and behavior of salmon and steelhead downstream of the fish ladder.

5.2.5.4.Special Studies

Water quality instruments for the Lake Washington Ship Canal data collection program were updated in 2004. New Hydrolab MiniSonde 4a water quality sondes and new Hydrolab cables were installed at all stations.

5.2.5.5.Coordination with Other Agencies

The Seattle District continued to work together with the Washington Department of Ecology to minimize saltwater intrusion into Lake Washington.

5.2.5.6.Scheduling Evaluations

No evaluations scheduled at this time

5.2.5.7.Problems with Contracted Work

None in 2004.

5.2.5.8.Innovative Techniques to Improve Water Quality

The Seattle District uses numerous operational methods to minimize salt water intrusion. Mechanical methods used to reduce salt water intrusion include salt water barriers installed in each lock as well as a salt water drain that removes denser salt water from the fresh water ship canal.

5.2.6. Mud Mountain Dam and the White River

5.2.6.1.Water Quality Conditions and Issues

Current Conditions: Good
Current Issues: Turbidity, sediments
Historical Problems: Turbidity, sediments
Future Problems: Turbidity, sediments

5.2.6.2.Future Problems: Turbidity, sediments Data Collection and Analysis

The Seattle District continued to monitor temperature and turbidity above and below Mud Mountain Dam to aid in regulating release patterns and to comply with state and federal regulations. Most water quality problems at Mud Mountain Dam are related to a high suspended-solids load associated with upstream glacial melt and erosion of sediment accumulations upstream of the project and in the reservoir. During and immediately following high flows and in association with some project maintenance

procedures, relatively short-term high turbidity levels will be experienced that will exceed State of Washington water quality standards.

5.2.6.3.Research and Development

None during 2004.

5.2.6.4.Special Studies

None during 2004.

5.2.6.5.Coordination with Other Agencies

None during 2004.

5.2.6.6.Scheduling Evaluations

No evaluations scheduled at this time.

5.2.6.7.Problems with Contracted Work

No contracted work.

5.2.6.8.Innovative Techniques to Improve Water Quality

None during 2004.

5.2.7. Wynoochee Dam

5.2.7.1.Water Quality Conditions and Issues

Current Conditions: Good
Current Issues: Temperature
Historical Problems: Temperature
Future Problems: Temperature

5.2.7.2.Data Collection and Analysis

During the summer stratification period, Tacoma Public Utilities and the City of Aberdeen collected in-situ measurements of temperature, dissolved oxygen, pH and specific conductivity at various depths in the water column, and furnished copies of the data to the Seattle District. The data were used to monitor reservoir thermal stratification at Wynoochee Dam.

The intake temperature panel system was used to regulate downstream temperatures during operation of the hydroelectric plant. The downstream temperature control point for the Wynoochee Project is the USGS River Gauging Station known as the Wynoochee River at Grisdale Gauge. A sensor at that gauging station reports river temperature on a real-time basis. In addition to the Grisdale Gauge, there is a sensor monitoring the temperature of the water in the hydroelectric plant tailrace.

5.2.7.3.Research and Development

None during 2004.

5.2.7.4.Special Studies

None during 2004.

5.2.7.5.Coordination with Other Agencies

The Seattle District coordinates all water quality monitoring at Wynoochee Dam with Tacoma Public Utilities.

5.2.7.6.Scheduling Evaluations

No evaluations scheduled at this time.

5.2.7.7.Problems with Contracted Work

None during 2004.

5.2.7.8.Innovative Techniques to Improve Water Quality

None during 2004.

5.2.8. TDG Fixed Monitoring Program

The Seattle District operates and maintains five total dissolved gas (TDG) and temperature fixed monitoring stations between April 1 and September 15 at three projects in the Columbia River Basin. Two stations (forebay and tailwater) are located at Chief Joseph Dam on the Columbia River, two stations (forebay and tailwater) are located at Albeni Falls Dam on the Pend Oreille River, and one station (tailwater) is located at Libby Dam on the Kootenai River. The purpose of the monitoring program is to provide real-time TDG data to the U.S. Army Corps of Engineers to allow for the understanding and management of flow and spill at dams on the Columbia River system.

5.2.9. TMDL Updates

Total maximum daily load (TMDL) plans have been proposed or issued on or near water bodies that impact Albeni Falls Dam and Chief Joseph Dam.

5.2.9.1.Albeni Falls Dam and the Pend Oreille River Basin

<u>Regulating Agency Actions:</u>

Temperature TMDL: The Washington Department of Ecology has issued a proposal for a temperature TMDL on the Pend Oreille River from the Idaho Boarder to the Canadian Boarder. The Idaho Department of Environmental Quality is proposing a temperature TMDL on the river from Lake Pend Oreille to the Washington State boarder.

Total Dissolved Gas TMDL: The Washington Department of Ecology has issued a proposal for a total dissolved gas TMDL on the Pend Oreille River from the Idaho Boarder to the Canadian Boarder.

Nutrient TMDL: The Idaho Department of Environmental Quality has developed and implemented a nearshore nutrient TMDL for Lake Pend Oreille and anticipates issuing a nutrient TMDL proposal for the Pend Oreille River downstream of Lake Pend Oreille to the Washington State Border.

Seattle District Actions:

The Seattle District implemented a two-year temperature study of Lake Pend Oreille and the Pend Oreille River system during 2004. Temperature monitoring will establish baseline information for the Pend Oreille River and Lake Pend Oreille during the summer months. This data will allow the Seattle District to define the potential relationship between Albeni Falls Dam operations and the temperature in the Pend Oreille River system upstream and downstream of the dam.

The District implemented real-time monitoring of total dissolved gas and temperature at forebay and tailwater fixed monitoring stations during the spill season from April 1 to September 15, 2004.

The District continued a total dissolved gas exchange study at Albeni Falls Dam, which investigated how project operations and spill patterns can reduce gas saturations in the Pend Oreille River downstream of the dam.

The District is proposing a water quality monitoring program at Albeni Falls Dam during 2005 to determine existing concentrations of conventionals, nutrients and metals in the Pend Oreille River system.

5.2.9.2.Chief Joseph Dam and the Columbia River Basin

Regulating Agency Actions:

Total Dissolved Gas TMDL: In 2004, the Washington Department of Ecology, EPA and the Spokane Tribe issued a total dissolved gas TMDL on the Mid-Columbia River and Lake Roosevelt from the Canadian Boarder to the confluence with the Snake River.

Temperature TMDL: The Washington Department of Ecology and EPA proposed a temperature TMDL on the Columbia River from the Canadian Boarder to the mouth. The status of this TMDL is uncertain.

Toxics TMDL: The Washington Department of Ecology and EPA have proposed a TMDL for contaminated sediments in Lake Roosevelt.

Seattle District Actions:

The Seattle District completed a two year temperature study of Lake Rufus Woods and the Mid-Columbia River downstream of Grand Coulee Dam during 2004. This data will allow the Seattle District to define the potential relationship between Chief Joseph Dam operations and the temperature in the Columbia River system upstream and downstream of the dam.

The District continued real-time monitoring of total dissolved gas and temperature at forebay and tailwater fixed monitoring stations during the spill season from April 1 to September 15, 2004.

The District implemented a joint operations procedure with Grand Coulee Dam to reduce TDG in the Mid-Columbia River by switching spill via the outlet works at Grand Coulee to the existing spillway at Chief Joseph.

The District continued the design, modeling, and construction of flow deflectors at Chief Joseph dam to reduce the TDG produced by spillway releases of water.

The District implemented a water quality and sediment quality monitoring program at Chief Joseph Dam and Lake Rufus Woods. Water quality monitoring will establish baseline information on the physical, chemical, and biological condition of Lake Rufus Woods and the Columbia River, and will better define the relationship between Chief Joseph Dam and the water quality in the Columbia River. Sediment quality monitoring will establish baseline information to help the Seattle District define the relationship, if any, between contaminated sediments in Lake Roosevelt upstream of Grand Coulee Dam and sediments in Lake Rufus Woods, upstream of Chief Joseph Dam.

5.3. Laboratory and Field Equipment, and Technical Capabilities

Seattle district water quality program requires various types of lab analysis, field equipment and technical expertise. The following is a list of how these needs are met.

The Seattle District continues to use a variety of environmental contractors for water quality and sediment quality sampling and analysis. A partial list of these contractors includes Aquatic Research, Analytical Resources, Seattle Public Utilities, Columbia Basin Environmental, USGS, and the COE Engineer Research and Development Center (ERDC).

The Seattle District maintains its own on-site laboratory for the collection and analysis of water and sediment samples. Analysis equipment available includes Hydrolab multi-probe water quality samplers (containing one or more of the following probes: total dissolved gas, turbidity, conductivity, pH, dissolved oxygen, temperature, depth), Orion pH, dissolved oxygen and conductivity meters, Hach turbidity meters, Vemco temperature loggers, and NIST certified thermometers and barometers. Sampling equipment available includes vertical point water samplers, a Ponar sediment sampler,

and a simple plankton net. In addition, each project in the Seattle District operates and maintains sampling boats equipped with winches and depth sounders. The on-site laboratory is equipped to handle the calibration of field instruments and the QA/QC of total dissolved gas and temperature instruments. The laboratory has equipment to maintain and repair Hydrolab and Orion sampling equipment. In addition, the laboratory has sieves and ovens for sediment analysis.

Equipment is purchased each year as needed and as funding permits in order to possess and maintain reliable and accurate equipment for measuring various water quality parameters. Laboratory equipment purchases in 2004 include but are not limited to Hydrolab MiniSonde 4a water quality probes and cables for the Lake Washington Ship Canal, Albeni Falls Dam, and Libby Dam projects, and Onset temperature loggers for the Albeni Falls Dam and Libby Dam projects. In addition, purchases of other equipment to assist in field collection such as water quality standards, flashlights, tools, hardware, and cables were made in 2004.

5.4. Regulation Changes

None during 2004.

5.5. Data Management Activities

The Seattle district water quality program is managing water quality data with current technology, which includes the following actions:

Hydraulics and Hydrology Section's primary real-time data management system is a microcomputer database using HEC-DSS with a user-friendly Visual Basic front-end. This database system has facilitated access and communication with the District's water control and water quality data collection system and has improved accessibility for data analysis and presentation. The Northwestern Division, Columbia Basin Region maintains a homepage that makes much of this data available to the public via the Internet. Data collection continues to be performed by Seattle District Office.

The database DASLER (Data Management and Analysis System for Lakes, Estuaries, and Rivers) was adopted in June 2003 in order to manage historic and current grab sample water quality data. The Seattle District will transfer grab sample data from DASLER to the EPA's water quality database STORET. Data continues to be entered into the database.

5.6. Water Quality Reports

Seattle district water quality staffs wrote, coordinated or contracted to have written several major reports associated with various water quality activities, and the following is a list of them:

Easthouse, K.B. and A.K. Klein. 2004. Total dissolved gas and temperature monitoring at Chief Joseph Dam, Washington and Libby Dam, Montana 2004: Data review and quality assurance. Final report prepared by the U.S. Army Corps of Engineers, Seattle District.

Easthouse, K.B. and A.K. Klein. 2004. Water temperature studies at Chief Joseph Dam, Washington 2003: Data review and quality assurance. Draft report prepared by the U.S. Army Corps of Engineers, Seattle District.

Schneider, M., 2004. Draft Total Dissolved Gas Exchange at Albeni Falls Dam May – June 2003. Draft report prepared for the U.S. Army Corps of Engineers, Seattle District by the U.S. Army Corps of Engineers, Engineer and Research Development Center (ERDC), Dallesport, WA.

U.S. COE. 2004. Albeni Falls Dam: Pend Oreille River and Lake Pend Oreille Temperature Monitoring Plan. U.S. Army Corps of Engineers, Seattle District.

U.S. COE. 2004. Howard A. Hanson Reservoir Water Quality Sampling and Analysis Plan. U.S. Army Corps of Engineers, Seattle District.

U.S. COE. 2004. Kootenai River Historical Water Temperature Data Collection and Analysis. Final memorandum prepared by the U.S. Army Corps of Engineers, Seattle District.

U.S. COE. 2004. Lake Washington Ship Canal Water Quality Monitoring and Analysis Plan. U.S. Army Corps of Engineers, Seattle District.

U.S. COE. 2004. Chief Joseph Dam Sampling and Analysis Plan. U.S. Army Corps of Engineers, Seattle District.

5.7. Meetings, Conferences, and Training

5.7.1. Participation in FY04

Seattle District staff attended several meetings, conferences and training, including

Kent Easthouse participated in various Program Management Plan meetings in Portland.

Kent Easthouse and Amy Klein attended the Transboundary Gas Group meeting in Stevenson, WA, April 2004.

Kent Easthouse attended the Transboundary Gas Group meeting in Penticton, B.C. October 2004.

Amy Klein attended training: ArcGIS Extensions Workshop: Spatial Analyst and 3D Analyst for Environmental Applications (GIS-404) NETC September 1-2, 2004.

Amy Klein attended training: Environmental Regulations in Washington State – An Overview of Federal and State Regulations in Washington June 2-3, 2004. Northwest Environmental Training Center (NETC).

Amy Klein attended training: Fundamental Chemistry for Environmental Professionals (CHEM-402) NETC April 13 - 14, 2004.

5.7.2. Required/Recommended Future Training for In-House Staff

The following is a list of future training for in-house staff:

Amy Klein: Recommend attending Hydrology and Hydraulics courses at the University of Washington in 2005.

Kent Easthouse and Amy Klein: Recommend attending the EPA's STORET database training course in 2005.

Amy Klein: Recommend attending data quality assurance training courses in 2005.

Amy Klein: Recommend attending the EPA's water quality standards course in 2005.

5.8. Personnel and Expenditures

The following is a summary of the personnel and expenditures including in house expenditures and contracts.

5.8.1. In-House Expenditures

The Seattle District's Water Quality Management Program consists of the following personnel:

Kent Easthouse:	Water quality scientist, GS-12, 1 FTE.
Ray Strode:	Lead technician, GS-11, ¼ FTE.
Linda Herman:	Database administrator, GS-11, ¼ FTE.
Amy Klein:	Biologist, field technician, GS-9, 1 FTE.

5.8.2. Contracts

The Seattle district contracts are summarized in Table 2:

Table 2

Seattle District Water Quality Contracts Awarded in 2004	**Amount**
1. U.S. Geological Survey (Montana District): Field water quality data collection/analysis on Lake Koocanusa/Kootenai River (3 reservoir stations, 1 Riverine station)	$72,000
2. Columbia Basin Environmental: Dissolved gas sensor operation and maintenance for Chief Joseph Dam, Albeni Falls Dam, and Libby Dam.	$25,000
3. Aquatic Research Inc.: Howard Hanson Reservoir Water Quality Analysis	$9,300
4. Aquatic Research Inc.: Chief Joseph Dam and Lake Rufus Woods Water Quality Analysis	$10,820
5. Analytical Resources Inc.: Colville Tribe Hatchery Water Quality Analysis	$4,800
6. Seattle Public Utilities: Howard Hanson Reservoir phytoplankton analysis	$1,000
7. Spokane Tribal Laboratories: Howard Hanson Reservoir and Chief Joseph zooplankton analysis	$1,500
8. Engineer Research and Development Center (ERDC): Albeni Falls Total Dissolved Gas Exchange Study.	$24,000
Total	**148,420**

5.9. Special Coordination with other Corps Entities

None during 2004.

5.10. Seattle District Summary

During 2004, the Seattle District Hydraulics and Hydrology Section continued to perform routine water quality data collection and evaluation at district projects, implement special studies and research projects, and coordinate monitoring efforts with local, state, and federal agencies. Achievement of the water quality management program 2004 objectives and goals stated in the Introduction Section are summarized below.

Objective 1: Continue routine water quality sampling at Libby Dam (Lake Koocanusa and the Kootenai River) and Howard Hanson Dam (Howard Hanson Reservoir and the Green River). Lake Koocanusa and Libby Dam, Howard Hanson Reservoir and Howard Hanson Dam, and Lake Rufus Woods and Chief Joseph Dam

Status: This water quality objective was achieved in 2004.

Objective 2: Continue real-time data collection of water quality temperature and salinity at the Lake Washington Ship Canal to assist in operational decisions of the ship canal and the locks for control of saltwater intrusion into Lake Washington.

Status: This water quality objective was achieved in 2004.

Objective 3: Continue real-time data collection system of hydrological, meteorological, and water quality data at rivers and reservoirs throughout Washington, Northern Idaho, and Western Montana.

Status: This water quality objective was achieved in 2004.

Objective 4: Continue a fish hatchery water quality study at Chief Joseph Dam to characterize the quality of relief tunnel, and forebay, and irrigation well waters to determine if these water sources meet water quality criteria for use at a proposed Colville Tribe fish hatchery.

Status: This water quality objective was achieved in 2004.

Perform a temperature study on the Pend Oreille River system near Albeni Falls Dam to assist in the development of an appropriate temperature TMDL and promote a better understanding how Albeni Falls Dam may impact the Pend Oreille River system.

Objective 5: Continue the temperature study at Libby Dam forebay to assess the accuracy of the automated temperature string on the face of the dam. Accurate readings are imperative for the selective withdrawal system and management of downstream water temperatures.

Status: This water quality objective was achieved in 2004.

Objective 6: Continue to work with together with the Bureau of Reclamation's Grand Coulee Dam and the Corps' Chief Joseph Dam to implement joint operations between Grand Coulee Dam and Chief Joseph Dam to reduce total dissolved gas levels on the Columbia River system.

Status: This water quality objective was achieved in 2004.

Objective 7: Continue to provide water quality and hydraulic expertise and support in the design and installation of flow-deflectors at Chief Joseph Dam to reduce TDG levels.

Status: This water quality objective was achieved in 2004.

Objective 8: Continue to monitor total dissolved gas (TDG) at five (5) permanent sites located at the forebay and tailwater of Chief Joseph Dam, the forebay and tailwater of Albeni Falls Dam, and the tailwater of Libby Dam.

Status: This water quality objective was achieved in 2004.

Objective 9: Continue to monitor water quality data at the East Bay Marina, Olympia Harbor, in South Puget Sound. Data is reviewed to determine when the Port of Olympia must operate its mechanical aeration system to increase dissolved oxygen levels to levels that are not harmful to fish.

Status: This water quality objective was achieved in 2004.

Objective 10: Continue to evaluate total dissolved gas management measures at Libby Dam, including installing at least one new generating unit, to allow high flows with reduced risk of spill and high TDG levels. Continue a total dissolved gas management study at Libby Dam to provide a feasibility assessment of various structural and operational alternatives to allow higher flows past the dam while reducing TDG saturations in the Kootenai River below the dam.

Status: This water quality objective was achieved in 2004.

Objective 11: Continue the water column temperature study at Chief Joseph Dam to evaluate water temperature increases in Lake Rufus Woods between Grand Coulee Dam and Chief Joseph Dam.

Status: This water quality objective was not achieved in 2004. The continuation of the temperature study at Chief Joseph Dam was canceled in 2004 because sufficient data were collected in 2002 and 2003 to evaluate temperature changes in Lake Rufus Woods. A final Chief Joseph Dam temperature study report was completed in January 2005.

Objective 12: Complete the 2003 total dissolved gas exchange study at Albeni Falls Dam to evaluate TDG in the Pend Oreille River during various spill conditions.

Status: This water quality objective was not achieved in 2004. Although a draft report was finished in 2004, a final report has not been completed. A final report is expected by May 2005.

Objective 13: Install permanent TDG monitoring stations at the forebay and tailwater of Albeni Falls Dam to monitor the impact of dam operations on the Pend Oreille River.

Status: This water quality objective was achieved in 2004.

Objective 14: Update water quality instruments for the Lake Washington Ship Canal data collection program.

Status: This water quality objective was achieved in 2004.

Objective 15: Implement a water quality study at Chief Joseph Dam to establish baseline information on the physical, chemical, and biological condition of Lake Rufus Woods and the Columbia River.

Status: This water quality objective was achieved in 2004.

Objective 16: Implement a sediment quality study at Chief Joseph Dam to establish baseline information on the physical and chemical condition of sediments in Lake Rufus Woods.

Status: This water quality objective was achieved in 2004.

Objective 17: Implement a water temperature study upstream and downstream of Albeni Falls Dam to establish baseline information for the Pend Oreille River system and Lake Pend Oreille for future TMDLs, and to study how Albeni Falls Dam may impact the Pend Oreille River system.

Status: This water quality objective was achieved in 2004.

6. Portland District Program

6.1. Introduction:

The Portland District manages water quality at 13 reservoirs within the Willamette River Basin, two reservoirs within the Rogue River Basin, the Sediment Retention Structure near Mt. St. Helens, and one reservoir on the Willow Creek tributary of the Columbia River. The Portland District also oversees the collection of data at a network of TDG fixed stations on the Lower Columbia River between John Day Dam and Camas, Washington. The objectives for FY04 were as follows:

1. Continue to operate and maintain stream-gauging programs in the Willamette and Rogue River Basins, Oregon, Willow Creek basin, and in Toutle River basin, Washington, and in the Lower Columbia River main stem.
2. Work with Oregon resource agencies to develop in-stream flow rules for the Willamette River requiring the Corps of Engineers to provide specific flows year-round for fisheries and water quality enhancement.
3. Continue coordination with resource agencies to assure Portland District's compliance with Federal and State water quality regulations at existing and proposed Federal projects.
4. Develop study plan for RAMS program and seek funding for Black Butte mine in the watershed of Cottage Grove Reservoir. Continue studies of mercury contamination in Cottage Grove and Dorena Reservoirs.

5. Continue selective withdrawal at Willow Creek Reservoir to aid locals in reducing temperatures in Willow Creek below the project.
6. Complete installation of aeration equipment at Willow Creek Reservoir to improve water quality by reducing H_2S and methane production.
7. Review historic and current data to determine problem specific water quality studies to conduct at Corps projects.
8. Continue to implement the District Fixed Monitoring Program (FMP) for monitoring TDG below Corps Projects in the lower Columbia River. Evaluate the need for dropping and/or moving FMP sites to improve the programs goal of monitoring compliance with water quality standards.
9. Continue to monitor TDG below Corps Projects in the Willamette and Rogue Basin on an as-needed basis.
10. Continue to participate with the USFS. and the city of Salem as a team member to monitor water quality in the North Santiam Watershed.
11. Implement plans and specifications for water quality monitoring during construction of the Selective Withdrawal Tower at Cougar Reservoir and Blue River Reservoir.
12. Continue to support efforts to set up water quality models of District Projects that have water quality problems.
13. Support the State and EPA in developing TMDLs for the Willamette and Columbia River.
14. Continue participation in developing a Water Quality Plan for District projects in the Lower Columbia River as required in the NMFS Biological Opinion on saving threatened fish species.
15. Obtain operation funding for water quality monitoring of the Lower Columbia River projects.
16. Develop budget projections for TMDL and BiOp work in the Willamette Basin.

6.2. Summary of Water Quality Conditions, Data Collection and Analysis, and other Activities/Investigations.

The Portland district water quality program activities during 2004 covers the Middle fork of the Willamette River, Rogue River, Columbia River, North and South Santiam Rivers, Coast Fork; Long Tom River; Blue River and Willow Creek. There was work associated with TMDLs performed too.

The Middle fork of the Willamette River projects include Hill Creek, Lookout Point, and Dexter reservoirs. The Rogue River, which the Applegate River flows into, includes Lost Creek and Applegate reservoirs. The Columbia River projects include Bonneville, John Day and The Dalles dams. The North and South Santiam Rivers projects include Detroit, Big Cliff, Green Peter and Foster reservoirs. Dorena reservoir is the only project located on the Row River. The Cottage Grove reservoir is the only project on the Coast Fork. The Fern Ridge reservoir is the only project on Long Tom River. The Blue River projects included Cougar reservoir and the Blue River itself. The Willow Creek reservoir is the only project

on Willow Creek. The following is the general overview of the water quality conditions, data collection/analysis and activities performed at these projects during 2004.

6.2.1. Hills Creek Dam

West Consultants, Inc. completed a CE-QUAL-W2 temperature model to aid in evaluating compliance with the temperature TMDL and to address future BiOp requirements. Dave Canoy, Environmental Testing Services, collected profile data at Hills Creek reservoir twice during the summer months for inclusion in the model.

6.2.2. Lookout Point Dam

West Consultants, Inc. completed a CE-QUAL-W2 temperature model to aid in evaluating compliance with the temperature TMDL and to address future BiOp requirements. Dave Canoy, Environmental Testing Services, collected profile data at Lookout Point reservoir twice during the summer months for inclusion in the model.

6.2.3. Dexter Dam

The Portland District advised Project personnel on water quality sampling techniques needed to address algae blooms that occur at Dexter during the summer months. West Consultants, Inc. completed a CE-QUAL-W2 temperature model to aid in evaluating compliance with the temperature TMDL and to address future BiOp requirements. Dave Canoy, Environmental Testing Services, collected profile data at Dexter reservoir twice during the summer months.

6.2.4. Lost Creek and Applegate Dams

John Salinas, the Cascade Research Group, collected temperature data at selected sites below Lost Creek and Applegate Reservoirs to obtain data on how far downstream each project impacts water temperature. Work will continue in 2005.

6.2.5. Bonneville, The Dalles, John Day Dams

The Waterways Experiment Station (ERDC) monitored total dissolved gas levels in the Columbia River below The Dalles dam from April to August 2004, after completion of the spillway guide wall, a wall that separating spill flow from powerhouse flow.

OA Systems installed and operated two hydrolab multiprobe samplers in the Columbia River, one in The Dalles spillway channel and the second in the upstream navigation lock wall at John Day Dam. The hydrolabs recorded water temperature, TDG, and depth. A real-time TDG monitor was added to the south side of the Bonneville spillway channel in April 2004. Remote profile temperature logging was continued in the John Day forebay. The purpose of the data collection was to provide provisional TDG data in support of the existing fixed monitoring system and the 2000 BiOp RPA 132.

6.2.6. Detroit and Big Cliff Dams

Portland District continued supporting USGS and the City of Salem turbidity data collection efforts to determine the impacts of projects and the North Santiam watershed on turbidity in the North Santiam River.

6.2.7. Green Peter and Foster Dams

West Consultants, Inc. completed a CE-QUAL-W2 temperature model to aid in evaluating compliance with the temperature TMDL and to address future BiOp requirements. Dave Canoy, Environmental Testing Services, collected profile data at Green Peter and Foster reservoirs twice during the summer months for inclusion in the model.

6.2.8. Dorena Dam

The Portland District reviewed the State's TMDL requirements for temperature, bacteria, and turbidity within the Willamette System.

6.2.9. Cottage Grove Dam

Coordinated with Oregon DEQ for a potential RAMS-funded assessment at Cottage Grove to improve mercury levels in the reservoir.

6.2.10. Fern Ridge Dam

The Portland District reviewed the State's TMDL requirements for temperature, bacteria, and turbidity within the Willamette System.

6.2.11. Cougar and Blue River Dams

The USGS continued operation of monitors for temperature and turbidity at Blue River (14162200) and McKenzie River near Vida (14162500), and streamflow, temperature, and turbidity at McKenzie River above the South Fork of the McKenzie River near Rainbow (14159110). They also conducted sediment sampling using two autosamplers at six locations to develop sediment-turbidity regressions on the McKenzie River and sampled water and suspended sediments during storm events for analysis of DDT and organic carbon. In July 2004, the USGS removed sediment traps from five locations on the McKenzie for analyzed the sediment for physical parameters and DDT.

The USFS collected twice-monthly profile data from three stations within Cougar Reservoir and three stations within Blue River Reservoir from February to November 2004. Work will continue through 2005.

6.2.12. Willow Creek Dam

The Dalles – John Day Project provided $50,000 in funding for the purchase of aeration equipment, which included one compressor and 12 aeration disks. The equipment installed in late May and early June 2004. To monitor the effectiveness of the equipment, the Portland District contracted Dr. Marvin Lilley, University of Washington, to monitor methane, hydrogen sulfide, nutrients, ammonia, metals, zooplankton, and phytoplankton at Willow Creek. Data was collected a three times during June, August, and October of 2004. Portland District also monitored the project oxygen levels frequently during the summer and fall. Preliminary data shows that the aerators appear to be increasing the circulation in the reservoir, with the result that temperatures in the reservoir from top to bottom are more uniform than historic data. Oxygen levels are higher at depth, while phosphorus and methane levels are decreased, and hydrogen sulfide is not detectable. However, continued monitoring will be required to evaluate the long-term effectiveness of the plan.

6.2.13. TMDL Activities

The Portland District reviewed the State's TMDL requirements for temperature, bacteria, and turbidity within the Willamette System, coordinated with the Oregon DEQ regarding the Corps assignment as a Designated Management Agency, and developed a water quality management plan for the Willamette projects. The Portland District also negotiated with the State regarding UAA requirements of the Rogue Basin temperature TMDL.

6.3. Laboratory and Field Equipment, and Technical Capabilities

Portland district water quality program requires various types of lab analysis, field equipment and technical expertise. The following is a list of how these needs are met.

1. Portland district does not operate or own laboratory facilities. The University of Washington analyzed nutrient samples. Aquatic Analysts analyzed phytoplankton samples. Zooplankton samples analyzed by ZP's Taxonomic Services.
2. The Portland District uses several environmental contractors to obtain field samples for water quality and sediment quality sampling and analysis. A partial list of these contractors includes Hart Crowser Inc., Cascade Research Group, Aquatic Analysts, Inc., USGS Oregon District, and the COE Engineer Research and Development Center (ERDC).
3. The USGS laboratory at the Water Resources Division was used for calibration, maintenance and repair of TDG saturometers and DCPs for the Fixed Monitoring Stations (FMSs).
4. Analysis equipment available for routine water quality monitoring include 3 Hydrolab multi-probe water quality samplers (containing one or more of the following probes: total dissolved gas, turbidity, conductivity, pH, dissolved oxygen, temperature, depth), 3 TDG saturometers (installed and maintained by the USGS), Orion pH, dissolved oxygen and conductivity meters, Hach turbidity meters, and NIST certified thermometers and barometers. Sampling equipment available includes vertical point water samplers, a Ponar sediment sampler, a box corer, and a gravity corer. A 16-foot john boat is available for reservoir work.

5. The Portland District purchased five hydrolab multiprobe samplers containing depth, temperature, and total dissolved gas probes for use at the Columbia River projects.
6. Ms. Laurie Rice joined the Reservoir Regulation and Water Quality Section in August 2004 as an EIT. She brings knowledge of sediment and water quality numerical modeling to the team. Laurie is assisting with hydraulic and hydrologic engineering studies, field work, and is developing an HEC5Q model for Cougar reservoir.

6.4. Regulation Changes.

There have been no changes in regulations that affected the Portland district water quality program during 2004.

6.5. Data Management Activities

The Portland district water quality program is managing water quality data with current technology, which includes the following actions:

1. Wendy Briner loaded all of the 2004 water quality data into the Dasler database and continued loading the remaining historical data into the DASLER database.
2. Daily reservoir reports and total dissolved gas monitoring reports for the Columbia River are available via the District WEB site under the Water Management page. Ralph Almeria with the Northwest Division office is responsible for maintenance of the data access.
3. Water quality monitoring data collected by contractors are being stored in a Water Quality Data folder on a central server. This allows data to be available in a central location for backups and updating.

6.6. Water Quality Reports

Portland district staff coordinated and contracted to have written several major reports associated with various water quality activities, including the following:

1. Tanner, D.Q., Johnston, M.W., and Bragg, H.M. (2004) Total Dissolved Gas and Water Temperature in the Lower Columbia River, Oregon and Washington, 2004, U.S. Geological Survey Water-Resources Investigations Report 2004-5249, 41 p.
2. Carroll, Joe H., Final Report, October 1, 2004: RPA 132: TDG Forebay Fixed Monitoring Station Review and Evaluation For John Day Dam, 2003.
3. West Consultants, Development of a CE-QUAL-W2 Model For Hills Creek Reservoir, April 2004, 43 p.
4. Schneider, Mike (2004) Memorandum: Trip Report February 6, 2004 regarding the TDG exchange at the Bonneville 2nd Powerhouse Corner Collector Outfall. 6 p.

6.7. Meetings, Conferences, and Training

6.7.1. Attended FY04

Portland district staffs attended several meetings, conferences and training, including:

- Wendy Briner and Donna Ebner attended Environmental Data Quality Management System (EDMS) and Automated Data Review (ADR) training at the Seattle District office; February 10-12, 2004.
- Wendy Briner and Donna Ebner attended ArcGis I and II course at ESRI; March 15-19, 2004.
- Wendy Briner and Donna Ebner attended an Ecosystem Restoration, Planning and Evaluation Prospect course; June 21-25, 2004.
- Wendy Briner attended a Wetland Riverine Functional Assessment Prospect course; October 18-21, 2004.
- Wendy Briner and Jim Britton attended the Setac World Conference; November 15-18, 2004.

6.7.2. Required/Recommended Future Training for In-House Staff Members

The following is a list of future training that in-house staffs plan to take:

- Laurie Rice attended a Transport of Sediment and Contaminants in Surface Water course at the University of California-Santa Barbara; January 16-21, 2005.
- Wendy Briner and Donna Ebner will be attending a Hydrologic Analysis for Ecosystem Restoration Prospect Course in May 2005.

6.8. Personnel and Expenditures

The following is a summary of the personnel and expenditures including in house expenditures and contracts.

6.8.1. In-House Expenditures

The Portland District's Water Quality Management Program consists of the following personnel:

Jim Britton:	Biologist, GS-12, 1 FTE.
Wendy Briner:	Biologist, GS-11, 1 FTE..
Donna Ebner:	Hydrologist, GS-11, 1/2 FTE.
Laurie Rice:	Civil Engineer, GS-11, 1/2 FTE.

In addition to water quality monitoring, Wendy Briner and Donna Ebner also work with the sediment quality group. Laurie Rice assists with sediment and water quality numerical modeling.

Table 3 is a summary of the in house expenditures.

Table 3
In House Expenditures

Company	Purchase	Cost
Hach Company	2 Hydrolab Multiprobes	$7,212.00
Hach Company	3 Hydrolab Multiprobes	$11,413.80
Total		18,625.80

6.8.2. Contracts

Table 4 is a summary of the contracts that Portland District water quality program has:

Table 4
Portland District Contracts

Company/Agency	NWP Project	Amount of Contract
University of Washington	Willow Creek	$38,000
Rogue River Community College	Lost Creek/Applegate	$29,500
OA Systems	Columbia River TDG	$43,900
USFS	Cougar/Blue River	$15,597
USGS	Columbia River TDG	$180,241
USGS	Cougar/McKenzie	$147,900
COE Hydrologic Engineering Center	Cougar Temperature Model	$52,000
ERDC	Columbia TDG	$109,494
BOR	Weather Stations	$10,500
WEST	CE-QUAL-W2 Models	$110,000
Total		$737,132

6.9. Special Coordination with other Corps Entities

Portland District participated in meetings with State and potential Federal partners to develop a plan for additional assessment at Black Butte Mine and corresponded with RAMS coordinators to attempt to secure funding for the plan. No funding was received in FY04.

6.10. Portland District Summary

During 2004, the Portland District Reservoir Regulation and Water Quality Section continued to perform routine water quality data collection and evaluation at district projects. Achievement of the water quality management program 2004 objectives and goals are summarized below.

- Portland District successfully installed and operated aeration equipment at Willow Creek reservoir that improved water quality conditions at the lake, including higher

dissolved oxygen levels, and lower methane, hydrogen sulfide, and nutrient concentrations. Monitoring will continue in 2005.

- CE-QUAL-W2 temperature models were completed for Hills Creek and Lookout Point reservoirs. Models are being developed for Green Peter and Foster reservoirs. Portland District continues their efforts to comply with the State's TMDL requirements and evaluate future BiOp requirements.

- Real-time TDG monitoring and temperature data collection continued at the Columbia River projects. Regular water quality monitoring continued at several Willamette and Rogue projects.

7. Summary

The Northwestern Division's water quality program can be summarized several different ways: personnel, number of projects and contracts. The following provides an overall summary of each:

7.1. Summary of Personnel

Table 5 provides a summary of the personnel who work on water quality issues. This summary lists the names, positions, grades and the amount of time they are involved in water quality issues.

Table 5
Summary of the Northwestern Division Personnel for Water Quality

Agency	Personnel	Position	Grade	Total FTEs
NWD - RCC	James Adams	Water Quality Team Leader	GS-13	1
NWD - RCC	Laura Hamilton	Environmental Engineer	GS-12	1
NWD - RCC	Tina Lundell	Engineer-In-Training	GS-5	0.5 [a]
NWD - RCC	Nancy Yun	Hydraulic Engineer	GS-12	0.5 [b]
NWW	Steve Juul	Water Quality Specialist	GS-12	1
NWW	Russ Heaton	Limnologist	GS-11	1
NWW	Phil Fishella	Limnologist	GS-11	1
NWP	Jim Britton:	Biologist	GS-12	1
NWP	Wendy Briner:	Biologist	GS-11	1
NWP	Donna Ebner:	Hydrologist	GS-11	0.5
NWP	Laurie Rice:	Civil Engineer	GS-11	0.5
NWS	Kent Easthouse	Water Quality Scientist	GS-12	1
NWS	Amy Klein	Biologist, field technician	GS-9	1
NWS	Ray Strode	Lead technician	GS-11	0.25
NWS	Linda Herman	Database administrator	GS-11	0.25
		NWD Total FTEs		**3**
		NWW Total FTEs		**3**
		NWS Total FTEs		**2.5**
		NWP Total FTEs		**3**
		Total NWD Division Wide FTEs		**11.5**

a - Tina Lundell graduated with a BS in civil engineering in June 2004 and has been on her 1 year Engineer in Training rotation

b - Nancy Yun was performing duties as a hydraulic engineer until May 2004 when she left the Corps on disability.

7.2. Summary of Projects

The Northwestern Division had a total of 38 projects associated with water quality during 2004. Table 6 provides a list of the water quality projects and the agency that deals with them.

Table 6
List of the Northwestern Division Personnel Water Quality Projects

Agency	Project
NWD - RCC	Spill management of the Columbia and Snake Rivers
NWD - RCC	TDG and Temperature monitoring of the Columbia and Snake Rivers
NWD - RCC	TDG modeling
NWD - RCC	Temperature modeling
NWD - RCC	Water Quality data management
NWD - RCC	Total maximum daily loads (TMDLs)
NWD - RCC	Use Attainability Analysis (UAA)
NWD - RCC	Regional Coordination and Water Quality Issues
NWW	McNary Project and Reservoir
NWW	Ice Harbor project and reservoir
NWW	Lower Monumental project and reservoir
NWW	Lower Granite project and reservoir
NWW	Dworshak project and reservoir
NWW	Mill Creek and Virgil B. Bennington Lake
NWW	Lucky Peak Reservoir (Boise River)
NWW	Lewiston Levees
NWW	TDG fixed monitoring program
NWS	Chief Joseph Dam and Lake Rufus Woods
NWS	Libby Dam and Lake Koocanusa
NWS	Albeni Falls dam and the Pend Oreille River
NWS	Howard Hanson dam and the Green River
NWS	Lake Washington Ship Canal
NWS	Mud Mountain dam and the White River
NWS	Wynoochee dam
NWS	TDG fixed monitoring program
NWS	TMDLs updates
NWP	Hills Creek dam
NWP	Lookout Point dam
NWP	Dexter dam
NWP	Lost Creek and Applegate dams
NWP	Bonneville, The Dalles, John Day dams
NWP	Detroit and Big Cliff dams
NWP	Green Peter and Foster dams
NWP	Dorena dam
NWP	Cottage Grove dam
NWP	Fern Ridge dam
NWP	Cougar dam and Blue River
NWP	Willow Creek
NWD	**Total number of projects = 8**
NWW	**Total number of projects = 9**
NWS	**Total number of projects = 9**
NWP	**Total number of projects = 12**

7.3. Summary of Contracts:

The Northwestern Division had a total of $2.6 Million of contracts associated with water quality during 2004. Table 7 provides a summary of these contracts and provides the names, positions, grades and the amount of time they are involved in water quality issues.

Table 7
Summary of Northwestern Division Contracts

Agency	Contract	Project	Amount
NWW	OA Sytems of Amarillo, TX	RPA 132 Review of Forebay Monitoring Study	$66,964
NWW	OA Sytems of Amarillo, TX	RPA 143 Temperature Modeling Study	$379,620
NWW	OA Sytems of Amarillo, TX	Water Velocity/ Temperature Study at McNary Dam Forebay	$222,772
NWW	OA Sytems of Amarillo, TX	Lower Monumental Near-Field Study	$57,057
NWW	ERDC - Vicksburg, MS	RPA 143 Temperature Modeling Study	$247,000
NWW	ERDC - Vicksburg, MS	Lower Monumental Near-Field Study	$15,000
NWW	USGS - Pasco, Wa	Routine system maintenance of FMS	$395,000
NWW		Other WQ expenditures	$238,000
NWW		Water temperature data collection	$8,200
NWW		FMS station equipment repair/ replacement	$61,075
NWW		RPA 143 field equipment	$17,812
NWS	U.S. Geological Survey (Montana District):	Field water quality data collection/analysis on Lake Koocanusa/Kootenai River (3 reservoir stations, 1 Riverine station)	$72,000
NWS	Columbia Basin Environmental:	Dissolved gas sensor operation and maintenance for Chief Joseph Dam, Albeni Falls Dam, and Libby Dam.	$25,000
NWS	Aquatic Research Inc.	Howard Hanson Reservoir Water Quality Analysis	$9,300
NWS	Aquatic Research Inc	Chief Joseph Dam and Lake Rufus Woods Water Quality Analysis	$10,820
NWS	Analytical Resources Inc.	Colville Tribe Hatchery Water Quality Analysis	$4,800
NWS	Seattle Public Utilities:	Howard Hanson Reservoir phytoplankton analyses	$1,000
NWS	Spokane Tribal Laboratories:	Howard Hanson Reservoir and Chief Joseph zooplankton analysis	$1,500
NWS	Engineer Research and Development Center (ERDC):	Albeni Falls Total Dissolved Gas Exchange Study.	$24,000
NWP	University of Washington	Willow Creek	$38,000
NWP	Rogue River Community College	Lost Creek/Applegate	$29,500
NWP	OA Systems	Columbia River TDG	$43,900
NWP	USFS	Cougar/Blue River	$15,597
NWP	USGS	Columbia River TDG	$180,241
NWP	USGS	Cougar/McKenzie	$147,900
NWP	COE Hydrologic Engineering Center	Cougar Temperature Model	$52,000
NWP	ERDC	Columbia TDG	$109,494
NWP	BOR	Weather Stations	$10,500
NWP	WEST	CE-QUAL-W2 Models	$110,000
		NWD Total Contracts Cost	**$0**
		NWP Total Contracts Cost	**$737,132**
		WWD Total Contract Costs	**$1,708,500**
		NWS Total Contracts Cost	**$148,420**
		Division Wide Total Contracts Cost	**$2,594,052**